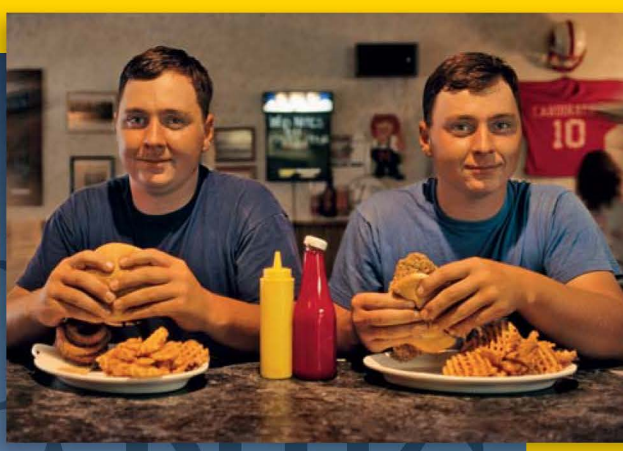
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DECEMBER 2014

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THE **JOY** OF FOOD

BRINGING FAMILY AND FRIENDS TOGETHER

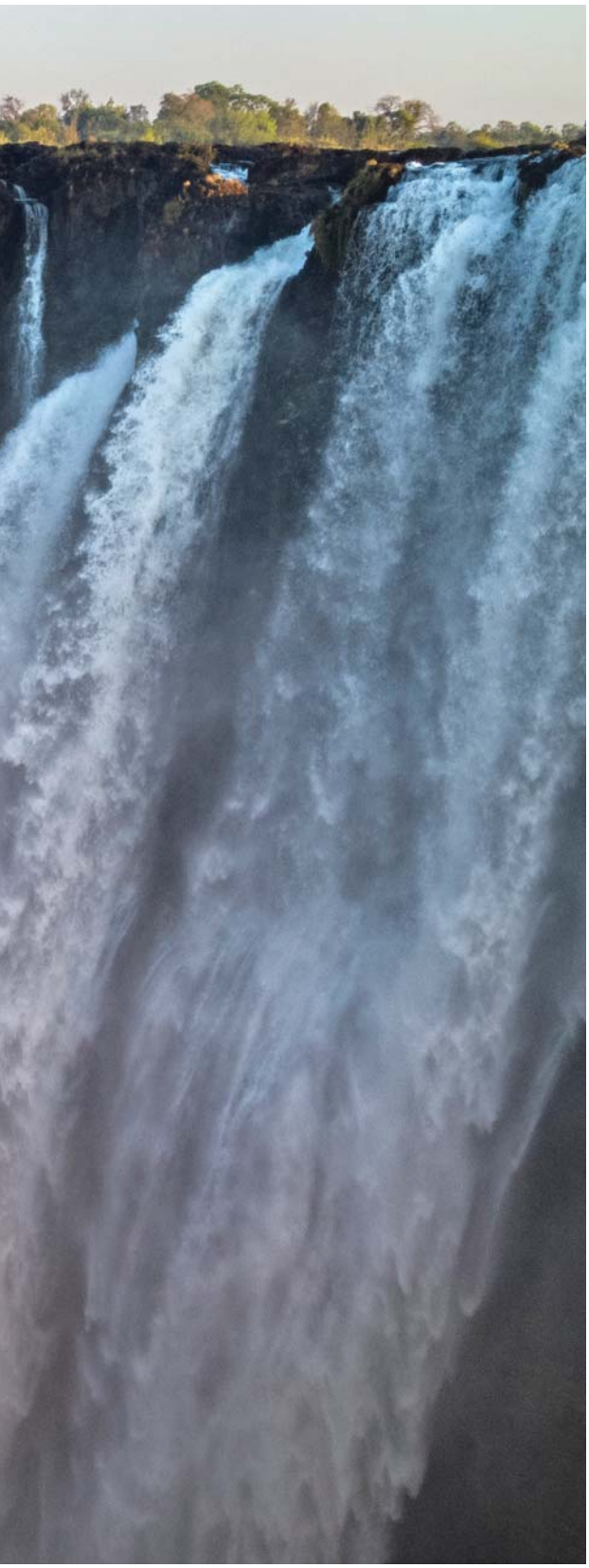
WALKING THROUGH THE **HOLY LANDS**

3-D PRINTERS REMAKING THE WORLD

PATAGONIA'S COWBOYS BLOOD & COURAGE



6:36 a.m., September 26, 2014
Victoria Falls, Zimbabwe/Zambia border
Shot with the Lumia 830



Microsoft



"Unstoppable Power"

"Leaning over the edge of the world's largest waterfall, the sheer power, energy, and thundering roar are indescribable. Of all the amazing wonders I've shot with a Lumia, what could compare with the overwhelming force of Victoria Falls?

Once again, I was stunned by the reliability and quality of Lumia smartphones. My Lumia 830 was unstoppable as I shot image after image of swirling water and huge African animals. It's so fast I caught this fleeting, almost circular rainbow created by the low angle of morning sun reflecting off mist from the Falls. I also knew that even if I dropped my Lumia in the Zambezi River, everything was backed up on OneDrive—all saved to view and share in one place. Having the whole assignment powered by Microsoft, from OneNote to OneDrive to my Lumia, made everything so much easier.

Victoria Falls is unbelievably vast, and I captured it all with a device that sits in the palm of my hand."
—Stephen Alvarez, National Geographic photographer



LUMIA 830

Follow my Victoria Falls expedition, and my journey through the Seven Natural Wonders of the World, at **www.nationalgeographic.com/microsoft**

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NATIONAL GEOGRAPHIC
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A security guard overlooks the scene in Bethlehem's Manger Square on Christmas Eve.

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#YOURPLATE SHOW US YOUR FEAST PHOTOS

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On the Cover
A beeswax-buffed apple looks good enough to eat.
Photos: Mark Thiessen, NGM Staff (apple); Joel Sartore

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FOOD

#YourPlate

Use the hashtag YourPlate to share photos of people coming together over food on Facebook, Twitter, and Instagram. Tag @NatGeo.



Twins Chris and Nick Holste first appeared in photographer Joel Sartore's November 1998 *Geographic* story on Nebraska. Sartore recently met up with the brothers (above), now 41, to re-create the original photo (see cover).



NG CHANNEL

This year Big Cat Week kicks off with the show *Man v. Lion,* airing November 30. To learn about lions' hunting and eating habits, host Boone Smith locks himself inside a box in the middle of a hungry pride, then watches as the lions devour a kill. For details on our Big Cats Initiative, visit *causeanuproar.org.*

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Corrections AUGUST 2014, VISIONS Pages 10-11: The item in the photo described as a traction engine is actually a portable steam boiler, likely once used to sterilize garden soil.

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PHOTO: MARIELLA FURRER, NATIONAL GEOGRAPHIC CHANNELS



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Always Learning

I've been at the National Geographic Society for almost a year now, and I am more convinced than ever: The most powerful teacher on the planet is media. I spent 20 years of my career at Sesame Workshop, focusing on the role of media in education through *Sesame Street*. This was followed by two years as CEO of National Public Radio, a global news organization. Coming here was a natural progression of my background in journalism and education. In fact I believe journalism and storytelling *are* education.

This past year we realigned our staff to better inspire, illuminate, and teach across all our platforms. We also renewed our focus on our founders' mission to report on science, exploration, and the environment through our media. I've been energized by the passion of our staff—and also by you, our members, and the millions of people in National Geographic's global community. You engage with us across screens large and small; you read our print books and magazines; you attend our exhibits and live events.

And there is more to come for you. In the year ahead we'll expand our reach to all ages. I hope you'll continue on the journey with National Geographic as a lifelong learner.



Gary E. Knell, *President and CEO*

PHOTO: MARK THIESSEN, NGM STAFF

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The Journey Continues

It's a truism that men won't ask directions. At least the men I know won't. Paul Salopek is the exception that proves the rule: On his 30-million-step, 21,000-mile, seven-year journey, Paul is one man willing to inquire about the way forward.

"I want to embed into the local cultures," he told me recently, as we walked in a hot, dusty corner of southern Turkey, just north of the Syrian border. Asking directions, he finds, not only gets you where you are going but also unlocks something deeper. "It gives the locals a chance to tell you about their city, about their story," Paul said. "They know more than you ever will."



Paul Salopek pauses in the Kidron Valley in the West Bank.

Sharing rich, contextual narratives is the point of his quest. Paul is undertaking a solo walk (with the exception of a small cast of guides, camels, mules, and the occasional visitor) that retraces the 60,000-year-old path of early humans, from the ancient site of Herto Bouri in Ethiopia to Tierra del Fuego at the tip of South America, the last corner of the continents settled by our ancestors. In an age of instant global news, Paul's determination to engage in what he calls "slow journalism" is a remarkable storytelling experiment for hurried times.

Paul, joined intermittently by photographer John Stanmeyer, has been documenting his journey ever eastward in *National Geographic,* including his trip through the Holy Land featured in this issue. And he regularly posts stories, his own photos, videos, and audio clips online at *outofedenwalk.nationalgeographic.com.* He encounters destitute refugees fleeing conflict, wealthy pilgrims seeking salvation, business people, nomads, farmers, everyone.

He stops—to ask directions, to talk, to listen, to synthesize. Only then does he write. As you read this, he has been on the road for almost two years, distilling the best from the oldest and newest forms of storytelling. "I am reminded often," he says, "of St. Augustine's rapture on this long, slow, improbable walk: How late have I loved thee, oh beauty, so ancient and so new."

We are honored to be a partner with Paul Salopek on this epic endeavor. Join us.



Susan Goldberg, *Editor in Chief*

PHOTO: JOHN STANMEYER



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Alexander Graham Bell with his grandson Melville. Beinn Bhreagh, Nova Scotia. Copyright © 2014 National Geographic Society

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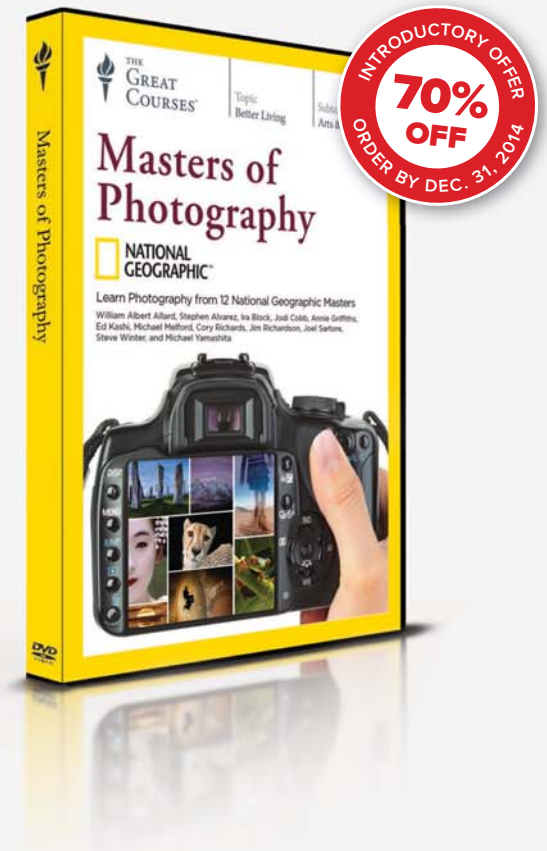
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Why I Want Kids to Go Play in the Parks

As U.S. secretary of the interior, Sally Jewell, 58, heads an agency responsible for managing energy and water resources on public lands and trust commitments to Native Americans. But perhaps the part of the job closest to her heart—she grew up in the Pacific Northwest and is an avid outdoorswoman—is acting as steward of America's national parks.

WHAT'S THE BIGGEST CHALLENGE FOR PARKS?
We need to make national parks relevant to new generations, to connect to people who have less time for a road trip or weekend campout with kids. We don't have enough people with parks on the radar as a place they want to go.

SO HOW DO YOU GET KIDS INTO NATIONAL PARKS?
We've started a four-part youth initiative: play, learn, serve, work. First is play. Let kids go to the park, explore, satisfy the curiosity that all kids have. When you nurture that curiosity, they build a comfort with being outside. Then comes learn. My favorite classroom is the one with no walls, whether it's natural national parks or historic national parks like battlefields or the places that tell the stories of civil rights. Then serve. When young people volunteer time to make a park better, they see what happens when people leave garbage or when invasive species take over, and they recognize what's at stake. They never look at that place the same again. And finally work. We want to put kids to work in youth corps, like the Civilian Conservation Corps did. The CCC connected millions of young men in the 1930s to public lands, and that connection never left them.

WILL TECHNOLOGY PLAY A PART IN THE PARKS?
Integrating technology into the parks experience is critical, even basics like being able to locate where you are on your smartphone so you can find out about that place. With technology you can keep park information up-to-date.

PHOTO: REBECCA HALE, NGM STAFF


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EXPLORE

Wild Things



Elephants and Trauma

Culling can cast a long shadow for elephants. Graeme Shannon and Karen McComb of the University of Sussex in the United Kingdom studied a population of elephants orphaned from culling operations and placed in South Africa's Pilanesberg National Park. They found that the practice, which involves killing older elephants and relocating young ones, has a strong effect on the behavior and social knowledge of surviving animals, causing symptoms similar to those experienced by people diagnosed with post-traumatic stress disorder.

South African wildlife officials used culling to control elephant populations from the mid-1960s until 1995. To gauge the effects, Shannon and McComb visited family groups in Pilanesberg and in Kenya's Amboseli National Park,



where culling didn't occur. They played recorded calls from elephants familiar and unfamiliar to each, and of various ages. The Amboseli elephants responded as expected: attentively bunched when they perceived high-level threats but relaxed when the calls signaled low-level threats. Pilanesberg elephants responded abnormally, showing no clear connection between threat level and reaction.

The behavioral ecologists attribute the abnormal responses to both the initial trauma and the loss of role models that culling caused. "Fundamental aspects of the elephant's complex social behavior may be significantly altered in the long term," their study says. And because elephants transfer knowledge, this abnormal behavior could be passed down for generations. *—Lindsay N. Smith*

Elephants cross a lake bed in Kenya's Amboseli National Park, where family groups were not subjected to culling.

PHOTO: NICK BRANDT

Riding on Rough Air

Some skies aren't so friendly, thanks to unpredictable bouts of turbulence. A United Airlines flight in February hit such rough air that a baby was thrown into the air (but wasn't harmed), one passenger's head made a dent in the ceiling, and five people later went to the hospital. Because of climate change, the extreme weather events that breed turbulence "are likely to become more frequent or more intense," says a U.S. Environmental Protection Agency report.

"Flight plans avoid known regions of severe turbulence, but these regions move, and it is difficult to predict exactly where the severe turbulence is going to be," says Sanjiva Lele of the Stanford-NASA Center for Turbulence Research. Help is on the way: Earlier this year one U.S. airline debuted new turbulence detectors that use special radar to predict the levels and location of turbulence in a flight path. *—Mark J. Miller*



CLEAR AIR TURBULENCE
The most common form of turbulence, this movement is often associated with the edges of the jet stream, a persistent atmospheric motion pattern in the Northern Hemisphere.



GRAVITY WAVES
Air that is forced upward, such as over mountains and above thunderstorms, causes gravity waves. Turbulence over mountains is common as two different, large air masses suddenly meet.



BAD WEATHER
Bumpy rides occur when planes fly through thunderstorms or after a rain, when warm air and cool air mix. Planes try to rise above such phenomena, but most can't fly higher than 45,000 feet.



WAKE FROM PLANES
Much as a boat's wake affects other craft, planes can suffer a major loss of control or altitude from wake turbulence. That's why air traffic control times takeoffs and landings to avoid it.



ALTERNATIVE ROCK

Some strange things are turning up on Hawaii's Kamilo Beach. They look like chunks of garbage but are actually pieces of a newly noted kind of stone. These "plastiglomerates" form when plastic litter melts in the heat of campfires and mixes with sand, basalt fragments, wood, and other debris. Sedimentologist Patricia Corcoran says that in Earth's future geologic record the stones could serve as markers of the point in civilization when humans started using (and discarding) plastics on a grand scale. *—Catherine Zuckerman*

PHOTO: REBECCA HALE, NGM STAFF. ART: SAMANTHA WELKER
SOURCE: SANJIVA LELE, STANFORD UNIVERSITY

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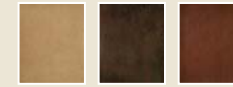
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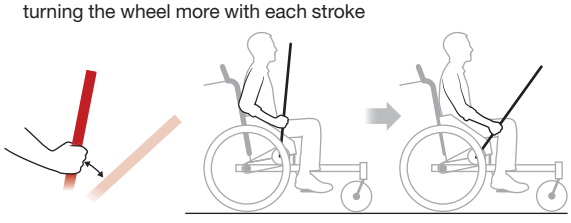


Wheelchair Revolution

In developing countries an estimated 20 million people need wheelchairs to get around—but standard wheelchairs, often donated, are not designed for negotiating rocky roads or sidewalk curbs. To solve the problem, a Massachusetts Institute of Technology team created the Leveraged Freedom Chair, a combination wheelchair and all-terrain trike. The LFC's drivetrain is made of inexpensive, replaceable bike parts available even in remote villages. Its inventors founded a start-up that's now producing the chairs and selling them to foundations, NGOs, and government agencies that distribute them for free. *—Karen de Seve*

HOW IT WORKS

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Grabbing high increases torque, decreasing user effort on rough terrain

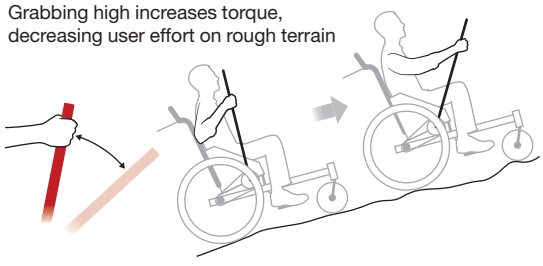


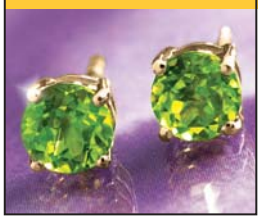
PHOTO: GLOBAL RESEARCH INNOVATION AND TECHNOLOGY. NGM ART
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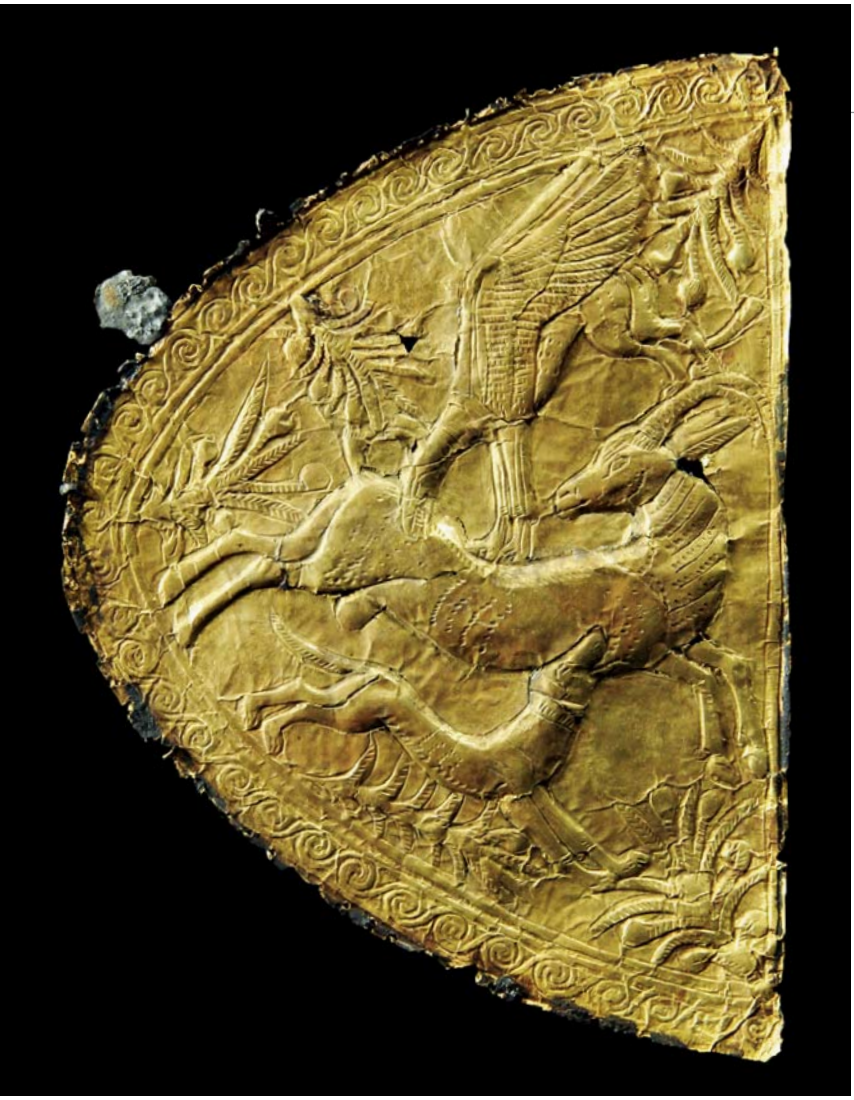
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One of about a hundred artifacts being studied, this gold foil measures 7.6 inches along its flat edge. Workers used a wooden tray to remove items from the underground tomb.



Royal Gold

When King Tut was buried in Egypt in about 1322 B.C., his treasure-filled tomb included two exceptionally ornate, gilded chariots. These vehicles were the limousines of their day, intended for parades and other grand occasions. They were put on display at the Egyptian Museum in Cairo shortly after archaeologist Howard Carter discovered the teenage pharaoh's final resting place in 1922. But the decorated gold foil pieces from their leather trappings were sent to storage.

The long-neglected artifacts are finally getting attention, following the launch of a German-Egyptian project to study and restore them. Experts are now working on the gold, leather, and adhesives and puzzling over the embossed scenes.

This piece (left)—likely from the lid to an archery bow's case—shows a dog and a mythical winged animal attacking an ibex. "This is not a motif that is familiar in Egypt," says Christian Eckmann, the project's metal expert. He and his colleagues will look for clues to where this art was made—in the region of Syria, perhaps, where such designs were common, or in Egypt itself, with designs borrowed from abroad. *—A. R. Williams*

PHOTOS: CHRISTIAN ECKMANN, RÖMISCH-GERMANISCHES ZENTRALMUSEUM, MAINZ, GERMANY (TOP); *LONDON TIMES/NEW YORK TIMES*/REDUX/NATIONAL GEOGRAPHIC CREATIVE



Enough to Go Around

Global undernourishment shouldn't exist. Each day the world's farmers produce the equivalent of 2,868 calories per person on the planet—enough to surpass the World Food Programme's recommended intake of 2,100 daily calories and enough to support a population inching toward nine billion. The world as a whole does not have a food deficit, but individual countries do.

Why do 805 million people still have too little to eat? Access is the main problem. Incomes and commodity prices establish where food goes. The quality of roads and airports determines how easily it gets there. Even measuring undernourishment is a challenge. In countries with the highest historical proportions of undernourishment, it can be hard to get food in and data out.

Things are slowly getting better. Since the early 1990s world hunger has dropped by 40 percent—that means 209 million fewer undernourished people, according to the Food and Agriculture Organization of the United Nations. Future progress may prove difficult. "It is critical to first improve overall food production and availability in places like sub-Saharan Africa," says FAO economist Josef Schmidhuber. "Then one can focus on access." *—Daniel Stone*

WHAT CAUSES HUNGER?

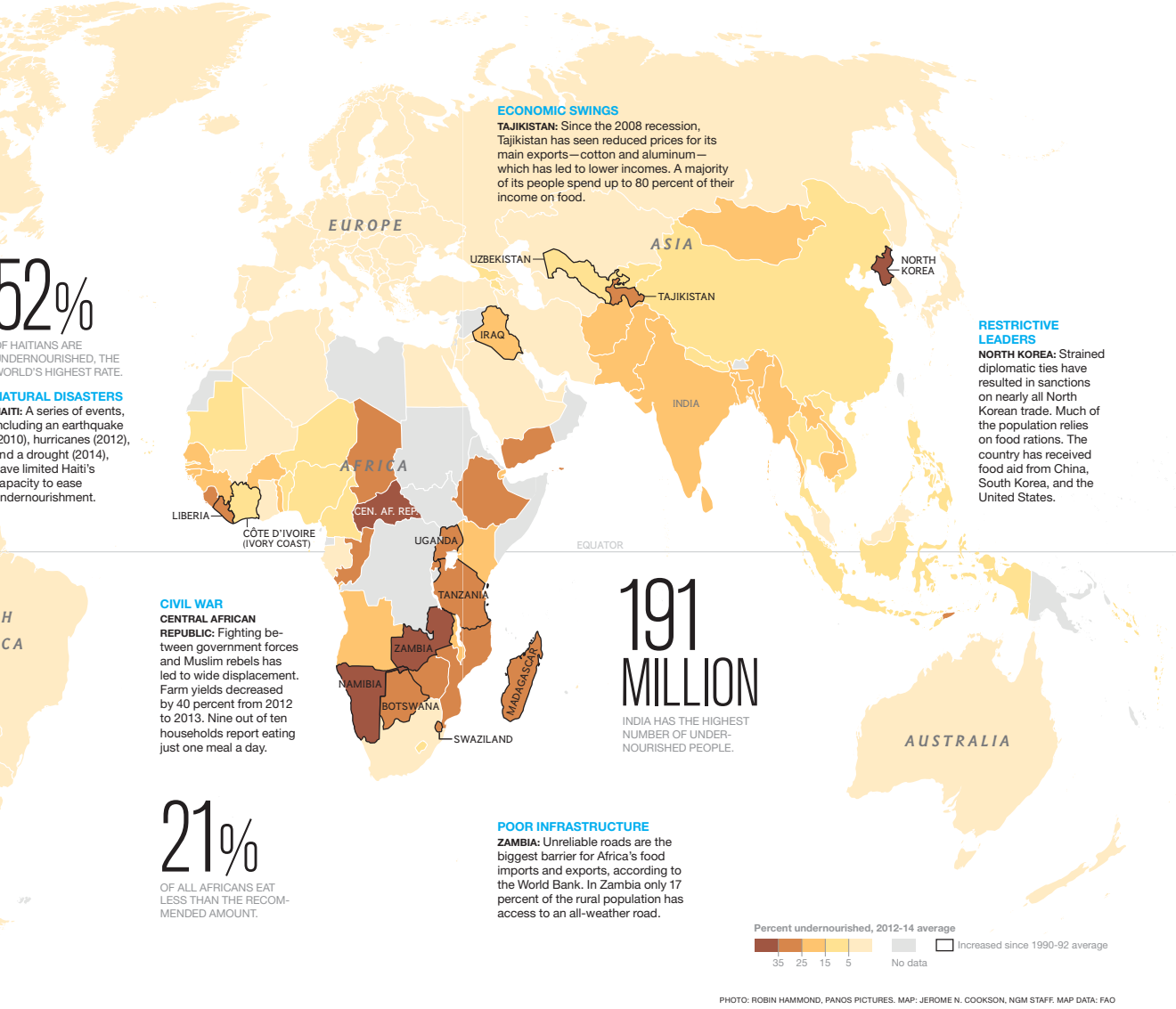
There are enough calories for everyone alive for other reasons—virtually all related to acc



ERRATIC WEATHER

BOLIVIA: Almost two-thirds of Bolivians living in rural areas depend on subsistence crops. Recurring droughts and floods bring food deficits. Undernourishment has stunted the growth of one-quarter of all children under five.

e. People go undernourished
cess.



52%

OF HAITIANS ARE UNDERNOURISHED, THE WORLD'S HIGHEST RATE.

NATURAL DISASTERS

HAITI: A series of events, including an earthquake (2010), hurricanes (2012), and a drought (2014), have limited Haiti's capacity to ease undernourishment.

ECONOMIC SWINGS

TAJIKISTAN: Since the 2008 recession, Tajikistan has seen reduced prices for its main exports—cotton and aluminum—which has led to lower incomes. A majority of its people spend up to 80 percent of their income on food.

RESTRICTIVE LEADERS

NORTH KOREA: Strained diplomatic ties have resulted in sanctions on nearly all North Korean trade. Much of the population relies on food rations. The country has received food aid from China, South Korea, and the United States.

CIVIL WAR

CENTRAL AFRICAN REPUBLIC: Fighting between government forces and Muslim rebels has led to wide displacement. Farm yields decreased by 40 percent from 2012 to 2013. Nine out of ten households report eating just one meal a day.

191 MILLION

INDIA HAS THE HIGHEST NUMBER OF UNDERNOURISHED PEOPLE.

21%

OF ALL AFRICANS EAT LESS THAN THE RECOMMENDED AMOUNT.

POOR INFRASTRUCTURE

ZAMBIA: Unreliable roads are the biggest barrier for Africa's food imports and exports, according to the World Bank. In Zambia only 17 percent of the rural population has access to an all-weather road.

Percent undernourished, 2012-14 average

35 25 15 5

No data

Increased since 1990-92 average

PHOTO: ROBIN HAMMOND, PANOS PICTURES. MAP: JEROME N. COOKSON, NGM STAFF. MAP DATA: FAO

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A partnership between Cargill and CARE has helped 100,000 people in eight countries, including these children in the Kutch district of India's Gujarat state. The six-year initiative promotes economic opportunities for rural families while enhancing educational and nutritional support for children.

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Cargill believes our global food system can produce enough food to meet the needs of an increasingly populous, more urban, and more prosperous world. How? Through the resilience of farmers; the responsible adoption of technology; and the effectiveness of market-based approaches to encourage production and move food efficiently.

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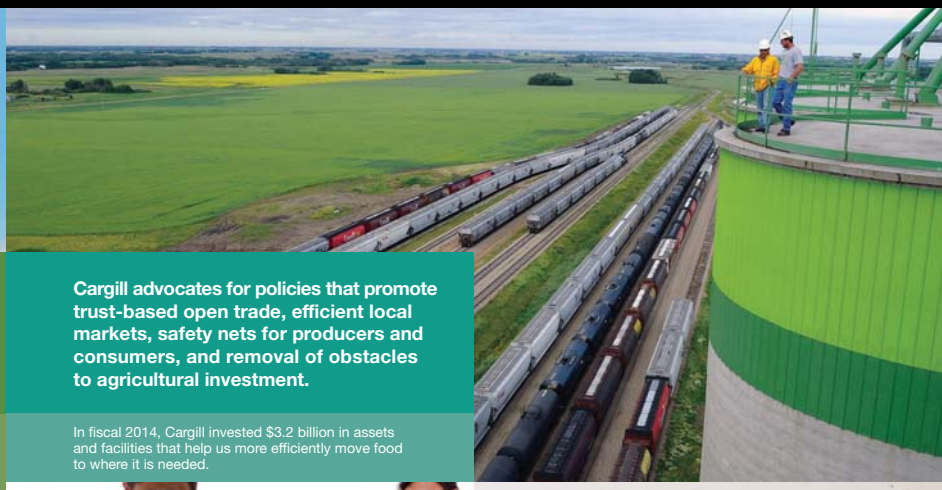
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are committed to helping feed world's growing population while he same time protecting the planet— porting Cargill's vision to be the al leader in nourishing people.

than 80 participants from the food industry, rnment, nonprofits and academia gathered in in 2013 as part of a "learning journey" hosted rgill to address challenges and identify solutions proving soy sustainability.





Cargill advocates for policies that promote trust-based open trade, efficient local markets, safety nets for producers and consumers, and removal of obstacles to agricultural investment.

In fiscal 2014, Cargill invested $3.2 billion in assets and facilities that help us more efficiently move food to where it is needed.



We help farmers increase agricultural productivity and incomes while ensuring responsible use of natural resources. Every year, Cargill works directly with millions of farmers to help them raise more food more sustainably, reach more markets, receive fair pricing and improve their standards of living.

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Cargill expands access to food, improves nutrition and pursues partnerships to end hunger in collaboration with the public, private and nonprofit sectors around the world.

Cargill's Truvia® business and the World Food Programme are fighting hunger in Bolivia— more than 49,700 children have received school meals.

/foodsecureworld.

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During the Christmas truce near Ploegsteert, Belgium, German and British troops posed for photos together.

The Christmas Truce



In December 1914 invading German troops and the defending Allies were dug in along battle lines in Belgium and France. From sodden trenches soldiers shot at each other across a no-man's-land strewn with injured and dead comrades. But on December 24, at points along that western front, Germans placed lighted trees on trench parapets and the Allies joined them in an impromptu peace: the Christmas truce of World War I, a hundred years ago this month.

The truce "bubbled up from the ranks" despite edicts against fraternization, says historian Stanley Weintraub, whose book *Silent Night* tells the story. After shouted exchanges promising, "You no shoot, we no shoot," some erstwhile enemies serenaded each other with carols. Others emerged from trenches to shake hands and share a smoke. Many agreed to extend the peace into Christmas Day, so they could meet again and bury their dead. Each side helped the other dig graves and hold memorials; at one, a Scottish chaplain led a bilingual recitation of the 23rd Psalm. Troops shared food and gifts sent from home, traded uniform buttons as souvenirs, and competed in soccer matches.

"No one there wanted to continue the war," Weintraub says. But the top brass did, and threatened to punish troops shirking duty. As the new year began, both sides "went on with the grim business at hand," Weintraub says. But they fondly recalled the truce in letters home and diary entries: "How marvelously wonderful," a German soldier wrote, "yet how strange." —*Patricia Edmonds*

PHOTO: CHRONICLE/ALAMY. NGM MAPS



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VISIONS





Japan
A young woman rides an escalator through the kaleidoscopic entrance to the Tokyu Plaza Omotesando Harajuku mall in Tokyo. Behind her, mirrors reflect the images of shoppers in one of the city's most fashionable districts.

PHOTO: DINA LITOVSKY, POLARIS





Indonesia
At a slaughterhouse in Kertasura dead snakes are rolled up before being sold for food or traditional medicine. Villagers hunt the reptiles to supplement their income—and feed the billion-dollar global snake trade.

PHOTO: NURCHOLIS ANHARI LUBIS, GETTY IMAGES



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India
Brides with henna-decorated hands wait for their group wedding to begin. Thirty-five couples in Mumbai participated in the ceremony, which was arranged by a Muslim social organization to cut costs for poor families.

PHOTO: DANISH SIDDIQUI, REUTERS

Editor's Choice

Daily Dozen Editors pick 12 photos from those submitted online each day. Here are our favorites this month.



EDITOR'S NOTE

"Sometimes very different photos can go well together. The thing that unites these two is technique. Both shots look almost effortless, but a great deal of skill went into them."

—Jeanne Modderman, photo editor



Peter Mather
Whitehorse, Canada

Mather set a camera near a nest of northern flickers in the Canadian Yukon. Using a remote trigger, he shot photos of one bird as it spent the day finding food and bringing it back to the nest.

Doug Stremel
Lawrence, Kansas

On a ranch in Clements, Kansas, Stremel watched a controlled burn sear the land. "It was one of those times when you know you're going to get a good shot no matter what you shoot," he says. As he kneeled, his pants caught fire.



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Embrace the Untamed

Assignment Point your camera toward our planet, we said. The Your Shot community responded with images of Earth's wonders.



Boris Basic
Dubrovnik, Croatia

As storms approached his hometown, Basic joined a group of storm chasers to find the best vantage point. He set up for a few long exposures, then created this photo composite of six separate frames.



Roman Golubenko
North Bergen, New Jersey

Golubenko, a photographer, says he learned in Alaska that wildlife photography tends to be spontaneous. Sometimes animals are skittish. "But if I'm lucky," he says, "I meet otters that all of a sudden decide to be playful and even pose for me."



COPD making you huff and puff?



SYMBICORT could help you breathe better, starting within 5 minutes.*
SYMBICORT does not replace a rescue inhaler for sudden symptoms.

COPD can make it hard to get air out, which can make it hard to get air in. SYMBICORT is a twice-daily maintenance medication for adults with COPD, including chronic bronchitis and emphysema, that could help make a significant difference in your breathing.* ***Ask your doctor about SYMBICORT.***

*Results may vary.

IMPORTANT INFORMATION ABOUT SYMBICORT

Important Safety Information About SYMBICORT

SYMBICORT contains formoterol, a long-acting beta$_2$-adrenergic agonist (LABA). LABA medicines such as formoterol increase the risk of death from asthma problems. It is not known whether budesonide, the other medicine in SYMBICORT, reduces the risk of death from asthma problems seen with formoterol.

- **Call your health care provider if breathing problems worsen over time while using SYMBICORT. You may need different treatment**
- **Get emergency medical care if:**
 - Breathing problems worsen quickly, and
 - You use your rescue inhaler medicine, but it does not relieve your breathing problems

SYMBICORT does not replace rescue inhalers for sudden symptoms.

Be sure to tell your health care provider about all your health conditions, including heart conditions or high blood pressure, and all medicines you may be taking. Some patients taking SYMBICORT may experience increased blood pressure, heart rate, or change in heart rhythm.

Do not use SYMBICORT more often than prescribed. While taking SYMBICORT, never use another medicine containing a LABA for any reason. Ask your health care provider or pharmacist if any of your other medicines are LABA medicines.

SYMBICORT can cause serious side effects, including:

- **Pneumonia and other lower respiratory tract infections.** People with COPD may have a higher chance of pneumonia. Call your doctor if you notice any of the following symptoms: change in amount or color of mucus, fever, chills, increased cough, or increased breathing problems
- **Serious allergic reactions** including rash, hives, swelling of the face, mouth and tongue, and breathing problems
- **Immune system effect and a higher chance of infection.** Tell your health care provider if you think you are exposed to infections such as chicken pox or measles, or if you have any signs of infection such as fever, pain, body aches, chills, feeling tired, nausea, or vomiting
- **Adrenal insufficiency.** This can happen when you stop taking oral corticosteroid medicines and start inhaled corticosteroid medicine
- **Using too much of a LABA medicine** may cause chest pain, increase in blood pressure, fast and irregular heartbeat, headache, tremor, or nervousness
- **Increased wheezing** right after taking SYMBICORT. Always have a rescue inhaler with you to treat sudden wheezing
- **Eye problems including glaucoma and cataracts.** You should have regular eye exams while using SYMBICORT
- **Lower bone mineral density** can happen in people who have a high chance for low bone mineral density (osteoporosis)
- **Swelling of blood vessels** (signs include a feeling of pins and needles or numbness of arms or legs, flu like symptoms, rash, pain or swelling of the sinuses), decrease in blood potassium and increase in blood sugar levels

Common side effects in **patients with COPD** include inflammation of the nasal passages and throat, thrush in the mouth and throat, bronchitis, sinusitis, and upper respiratory tract infection.

Approved Uses for SYMBICORT

SYMBICORT 160/4.5 is for adults with COPD, including chronic bronchitis and emphysema. You should only take 2 inhalations of SYMBICORT twice a day. Higher doses will not provide additional benefits.

Please see full Prescribing Information and Medication Guide and discuss with your doctor.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch or call 1-800-FDA-1088.

FREE Prescription Offer†
Call 1-877-389-4030 or visit MySymbicort.com
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Symbicort® 160/4.5
(budesonide/formoterol fumarate dihydrate)
Inhalation Aerosol

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AstraZeneca

IMPORTANT INFORMATION ABOUT SYMBICORT

Please read this summary carefully and then ask your doctor about SYMBICORT.

No advertisement can provide all the information needed to determine if a drug is right for you or take the place of careful discussions with your health care provider. Only your health care provider has the training to weigh the risks and benefits of a prescription drug.

WHAT IS THE MOST IMPORTANT INFORMATION I SHOULD KNOW ABOUT SYMBICORT?

People with asthma who take long-acting beta$_2$-agonist (LABA) medicines, such as formoterol (one of the medicines in SYMBICORT), have an increased risk of death from asthma problems. It is not known whether budesonide, the other medicine in SYMBICORT, reduces the risk of death from asthma problems seen with formoterol.

SYMBICORT should be used only if your health care provider decides that your asthma is not well controlled with a long-term asthma control medicine, such as an inhaled corticosteroid, or that your asthma is severe enough to begin treatment with SYMBICORT. Talk with your health care provider about this risk and the benefits of treating your asthma with SYMBICORT.

If you are taking SYMBICORT, see your health care provider if your asthma does not improve or gets worse. It is important that your health care provider assess your asthma control on a regular basis. Your doctor will decide if it is possible for you to stop taking SYMBICORT and start taking a long-term asthma control medicine without loss of asthma control.

Get emergency medical care if:

- breathing problems worsen quickly, and
- you use your rescue inhaler medicine, but it does not relieve your breathing problems.

Children and adolescents who take LABA medicines may be at increased risk of being hospitalized for asthma problems.

WHAT IS SYMBICORT?

SYMBICORT is an inhaled prescription medicine used for asthma and chronic obstructive pulmonary disease (COPD). It contains two medicines:

- Budesonide (the same medicine found in Pulmicort Flexhaler™, an inhaled corticosteroid). Inhaled corticosteroids help to decrease inflammation in the lungs. Inflammation in the lungs can lead to asthma symptoms
- Formoterol (the same medicine found in Foradil® Aerolizer®). LABA medicines are used in patients with COPD and asthma to help the muscles in the airways of your lungs stay relaxed to prevent asthma symptoms, such as wheezing and shortness of breath. These symptoms can happen when the muscles in the airways tighten. This makes it hard to breathe, which, in severe cases, can cause breathing to stop completely if not treated right away

SYMBICORT is used for asthma and chronic obstructive pulmonary disease as follows:

Asthma

SYMBICORT is used to control symptoms of asthma and prevent symptoms such as wheezing in adults and children ages 12 and older.

Chronic Obstructive Pulmonary Disease

COPD is a chronic lung disease that includes chronic bronchitis, emphysema, or both. SYMBICORT 160/4.5 mcg is used long term, two times each day, to help improve lung function for better breathing in adults with COPD.

WHO SHOULD NOT USE SYMBICORT?

Do not use SYMBICORT to treat sudden severe symptoms of asthma or COPD or if you are allergic to any of the ingredients in SYMBICORT.

WHAT SHOULD I TELL MY HEALTH CARE PROVIDER BEFORE USING SYMBICORT?

Tell your health care provider about all of your health conditions, including if you:

- have heart problems
- have high blood pressure
- have seizures
- have thyroid problems
- have diabetes
- have liver problems
- have osteoporosis
- have an immune system problem
- have eye problems such as increased pressure in the eye, glaucoma, or cataracts
- are allergic to any medicines
- are exposed to chicken pox or measles
- **are pregnant or planning to become pregnant.** It is not known if SYMBICORT may harm your unborn baby
- **are breast-feeding.** Budesonide, one of the active ingredients in SYMBICORT, passes into breast milk. You and your health care provider should decide if you will take SYMBICORT while breast-feeding

Tell your health care provider about all the medicines you take including prescription and nonprescription medicines, vitamins, and herbal supplements. SYMBICORT and certain other medicines may interact with each other and can cause serious side effects. Know all the medicines you take. Keep a list and show it to your health care provider and pharmacist each time you get a new medicine.

HOW DO I USE SYMBICORT?

Do not use SYMBICORT unless your health care provider has taught you and you understand everything. Ask your health care provider or pharmacist if you have any questions.

Use SYMBICORT exactly as prescribed. **Do not use SYMBICORT more often than prescribed.** SYMBICORT comes in two strengths for asthma: 80/4.5 mcg and 160/4.5 mcg. Your health care provider will prescribe the strength that is best for you. SYMBICORT 160/4.5 mcg is the approved dosage for COPD.

- SYMBICORT should be taken every day as 2 puffs in the morning and 2 puffs in the evening.
- Rinse your mouth with water and spit the water out after each dose (2 puffs) of SYMBICORT. This will help lessen the chance of getting a fungus infection (thrush) in the mouth and throat.
- Do not spray SYMBICORT in your eyes. If you accidentally get SYMBICORT in your eyes, rinse your eyes with water. If redness or irritation persists, call your health care provider.
- Do not change or stop any medicines used to control or treat your breathing problems. Your health care provider will change your medicines as needed
- **While you are using SYMBICORT 2 times each day, do not use other medicines that contain a long-acting beta$_2$-agonist (LABA) for any reason. Ask your health care provider or pharmacist if any of your other medicines are LABA medicines.**
- SYMBICORT does not relieve sudden symptoms. Always have a rescue inhaler medicine with you to treat sudden symptoms. If you do not have a rescue inhaler, call your health care provider to have one prescribed for you.

Call your health care provider or get medical care right away if:

- your breathing problems worsen with SYMBICORT
- you need to use your rescue inhaler medicine more often than usual
- your rescue inhaler does not work as well for you at relieving symptoms
- you need to use 4 or more inhalations of your rescue inhaler medicine for 2 or more days in a row
- you use one whole canister of your rescue inhaler medicine in 8 weeks' time
- your peak flow meter results decrease. Your health care provider will tell you the numbers that are right for you
- your symptoms do not improve after using SYMBICORT regularly for 1 week

WHAT MEDICATIONS SHOULD I NOT TAKE WHEN USING SYMBICORT?

While you are using SYMBICORT, do not use other medicines that contain a long-acting beta$_2$-agonist (LABA) for any reason, such as:

- Serevent® Diskus® (salmeterol xinafoate inhalation powder)
- Advair Diskus® or Advair® HFA (fluticasone propionate and salmeterol)
- Formoterol-containing products such as Foradil Aerolizer, Brovana®, or Perforomist®

WHAT ARE THE POSSIBLE SIDE EFFECTS WITH SYMBICORT?

SYMBICORT can cause serious side effects.

- Increased risk of pneumonia and other lower respiratory tract infections if you have COPD. Call your health care provider if you notice any of these symptoms: increase in mucus production, change in mucus color, fever, chills, increased cough, increased breathing problems
- Serious allergic reactions including rash; hives; swelling of the face, mouth and tongue; and breathing problems. Call your health care provider or get emergency care if you get any of these symptoms
- Immune system effects and a higher chance for infections
- Adrenal insufficiency–a condition in which the adrenal glands do not make enough steroid hormones
- Cardiovascular and central nervous system effects of LABAs, such as chest pain, increased blood pressure, fast or irregular heartbeat, tremor, or nervousness
- Increased wheezing right after taking SYMBICORT
- Eye problems, including glaucoma and cataracts. You should have regular eye exams while using SYMBICORT
- Osteoporosis. People at risk for increased bone loss may have a greater risk with SYMBICORT
- Slowed growth in children. As a result, growth should be carefully monitored
- Swelling of your blood vessels. This can happen in people with asthma
- Decreases in blood potassium levels and increases in blood sugar levels

WHAT ARE COMMON SIDE EFFECTS OF SYMBICORT?

Patients with Asthma

Sore throat, headache, upper respiratory tract infection, thrush in the mouth and throat

Patients with COPD

Thrush in the mouth and throat

These are not all the side effects with SYMBICORT. Ask your health care provider or pharmacist for more information.

NOTE: This summary provides important information about SYMBICORT. For more information, please ask your doctor or health care provider.

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By implanting a nucleus inside the oyster, farmers stimulate the natural creation of a pearl. Each Mitsuko cultured pearl is harvested, polished and strung by hand.

It's okay to be skeptical. You have every right to be. Why would any company give away a pearl necklace? Good question. We believe that once you try us, you'll be back for more. But maybe a better question is why other luxury jewelers don't think twice about offering cultured pearls for hundreds—even thousands—more. I'm sure they have their reasons. But you don't have to fall for them. Not anymore. Call today for your **FREE *Mitsuko Organic Cultured Pearl Necklace*** and you'll realize that luxury doesn't have to cost a fortune.

Mitsuko Organic Cultured Pearls—Exclusively from Stauer. Every necklace is the product of generations of expertise. From natural genesis to final selection, imported Mitsuko organic cultured pearls are held to the highest standard. This continous, 26" strand showcases a collection of 6½-7mm white cultured pearls. Each necklace is hand-strung and double-knotted to keep every precious pearl secure.

This exclusive FREE offer can't last forever. Unfortunately, we are only able to make a limited number of these necklaces available to the public for free. Don't let this incredible opportunity pass you by! To ensure that you receive your ***FREE Mitsuko Organic Cultured Pearl Necklace***, please call today. Your idea of luxury will never be the same!

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† Free is for Call-In Customers only versus the original Stauer.com price.

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Please mention this code when you call.

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* This offer is valid in the United States (and Puerto Rico) except in TX, FL, CO, OK, RI, NH, WV, OR, SC, VA and ID. These state residents will be charged one cent ($.01) + shipping & processing for the item. Void where prohibited or restricted by law. Offer subject to state and local regulations. Not valid with any other offers and only while supplies last. This offer is limited to one item per shipping address.

The Power of a Smile

Assignment We asked to see images of life's most universal expression.







EDITOR'S NOTE

"A normal photo can become wonderful when you've thought of every detail. The light, the clouds, a genuine expression of pure joy riding a bike. It's almost perfect."

—Marie McGrory, assistant photo editor

Chris Minihane *Great Falls, Virginia*
In Kenya, where bicycles can be scarce, Minihane wanted a portrait of a local boy riding. She bought a bike and tried to teach several boys to ride. "They'd crash every time," she says. Finally one managed to stay on just long enough.

Steven Chou *Beijing, China*
Chou was walking along a road in the Liangshan area of Sichuan, China, when he met a woman who had finished her farmwork for the day. He talked to her for a few minutes, then took her photo. The smile, he says, seemed sincere.

Amir Hamja *Chittagong, Bangladesh*
At a rice farm north of his town, Hamja saw two boys running around, playing with a kite. He was drawn to the transparent blur of the kite's material, so he asked the boys to slow down and smile.



The Mane Attraction

Billiards players got an unexpected equine spectator—if you look closely—in this 1920s photo from the Overland Park motor camp in Colorado. The nearby city of Denver established the 160-acre camp (one of 247 that had been built in the state by 1922) to serve the growing number of vacationers touring the West by car. Among Overland Park's amenities, besides a pool hall and a ballroom big enough for 500 dancers, was a "26-room community clubhouse for the campers, containing shower baths, rest and reading rooms, barber shop and large verandas for rocking chair rambles in the twilight," noted *American Motorist* in October 1922. The magazine went on: "And the moon is hung in the sky to help incandescent arcs romantically light one's way when bedtime comes." *—Margaret G. Zackowitz*

PHOTO: DENVER TOURIST BUREAU/NATIONAL GEOGRAPHIC CREATIVE

The Future of FOOD natgeofood.com

This special initiative explores how to sustainably feed everyone on our planet and celebrates the role food plays in our lives.

What is it about eating that brings us closer?

Food is more than survival.
With it we make friends, court lovers,
and count our blessings.

The Joy of Food



FOOD

THE SHARING OF FOOD has always been part of the human story. From Qesem Cave near Tel Aviv comes evidence of ancient meals prepared at a 300,000-year-old hearth, the oldest ever found, where diners gathered to eat together. Retrieved from the ashes of Vesuvius: a circular loaf of bread with scoring marks, baked to be divided. "To break bread together," a phrase as old as the Bible, captures the power of a meal to forge relationships, bury anger, provoke laughter. Children make mud pies, have tea parties, trade snacks to make friends, and mimic the rituals of adults. They celebrate with sweets from the time of their first birthday, and the association of food with love will continue throughout life—and in some belief systems, into the afterlife. Consider the cultures that leave delicacies graveside to let the departed know they are not forgotten. And even when times are tough, the urge to celebrate endures. In the Antarctic in 1902, during Robert Falcon Scott's *Discovery* expedition, the men prepared a fancy meal for Midwinter Day, the shortest day and longest night of the year. Hefty provisions had been brought on board. Forty-five live sheep were slaughtered and hung from the rigging, frozen by the elements until it was time to feast. The cold, the darkness, and the isolation were forgotten for a while. "With such a dinner," Scott wrote, "we agreed that life in the Antarctic Regions was worth living." —*Victoria Pope*

This wartime photograph was published in a 1916 issue of *National Geographic* with a caption referring to Adam, Eve, and the apple. But more germane is how the image evokes an idyllic British landscape and the childhood pleasure of a snack after play.

A. W. CUTLER, NATIONAL GEOGRAPHIC CREATIVE



Afghan women share a meal of flatbread, goat, lamb, and fruit in the Women's Garden, a refuge for conversation and confidences outside the city of Bamian. The garden and surrounding park were created to promote leisure activities for women and families. For this group it includes the chance to bond over food.


PEPSI





I got to thinking... about all those women on the Titanic *who passed up dessert.*

Erma Bombeck



After World War I, roadside eateries like the California snack bar at right became popular. At left, from top: In Portugal a truck sells German comfort food; in Washington, D.C., a PETA protester offers meatless hot dogs; in England a beachgoer eats a packed lunch.

FROM TOP: MARTIN ROEMERS, PANOS PICTURES; SUSANA RAAB; MARTIN PARR, MAGNUM PHOTOS
RIGHT: ALEXANDER WIEDERSEDER, NATIONAL GEOGRAPHIC CREATIVE


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CHILL
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CIDER
ICE TEA
COLD
DRINKS
COFFEE
WELCOME



In this 1894 photograph of an outing in the Maine woods, watermelon slices resemble oversize grins. Medieval hunting feasts and Renaissance outdoor banquets were precursors of the picnic, but the activity gained currency after the industrial revolution as a short, economical excursion.

BETTMANN/CORBIS







With good friends... and good food on the board... we may well ask, When shall we live if not now?

M.F.K. Fisher
The Art of Eating





A shared meal binds people together, whether they're a family saying grace (right), patients in a Croatian clinic (top), young men tucking into fried chicken in Accra, Ghana, or Buddhist priests near Shanghai supping on noodles in 1931.



LEFT, FROM TOP: CAROLYN DRAKE, PANOS PICTURES; ALFREDO CALIZ, PANOS PICTURES; PAUL DE GASTON, NATIONAL GEOGRAPHIC CREATIVE. ABOVE: H. ARMSTRONG ROBERTS, CLASSICSTOCK/CORBIS



The Sisters of the Visitation near Beirut, Lebanon, use a paste of almonds and sugar to make marzipan sweets, typically eaten around Easter. Foodstuffs are often a source of income for holy orders; the Trappists, for example, sell beer and cheese. These Maronite nuns make candy shaped like birds and flowers.







I will marry you if you promise not to make me eat eggplant.

Gabriel García Márquez
Love in the Time of Cholera



Meals as milestones, from top left: A cake marks a birthday in 1934. At the wedding feast of an Armenian couple in Nagorno-Karabakh, the meat dish *khorovats* is served along with song and dance. Foods are laid out in honor of the deceased in Belarus. At right: A joyful catch is made in Bristol Bay, Alaska.

FROM TOP: REMIE LOHSE, CONDÉ NAST ARCHIVE/CORBIS; ANASTASIA TAYLOR-LIND, VII; SIARHEI HUDZILIN. RIGHT: COREY ARNOLD





Four-year-old Seraphin Eskildsen is immersed in a bowl of porridge at his home in Denmark. For many, a favorite childhood food summons fond memories. Chef Jacques Pépin's was a baguette with a square of dark chocolate. For Julia Child, it was a vanilla-and-chocolate ice-cream sandwich.

JOAKIM ESKILDSEN



FOOD

The Communal Table

In Milpa Alta, Mexico, the faithful eat, pray, and celebrate to keep life whole.

BY VICTORIA POPE
PHOTOGRAPHS BY CAROLYN DRAKE



EVERY YEAR FOR MANY YEARS the people of Milpa Alta, Mexico, have prepared a meal before Christmas, the magnitude of which would seem to require a miracle. Sixty thousand tamales and 5,000 gallons of hot chocolate are made from scratch in less than a week, not too much and not too little for the thousands who show up for the feast.

The feeding of this multitude is no simple matter. "There is an infinity of things to do," Virginia Meza Torres says firmly, as if to signal no time to talk. She looks crisp and unruffled in a white piqué blouse. Her husband, Fermín Lara Jiménez, stands next to her on their patio, neatly dressed in a white polo shirt and gray vest. Virginia and Fermín are majordomos, handpicked to organize activities for the annual pilgrimage to the Chalma sanctuary, 59 miles away. They have waited 14 years to receive this sacred duty.

The feast is called La Rejunta, which translates as "the roundup," and it's a way to build anticipation for the pilgrimage, when some 20,000 men, women, and children from Milpa Alta walk through the mountains to the ancient place of the holy cave, where a life-size, darkened statue of Jesus, El Señor de Chalma, resides. Before the Spanish conquest indigenous deities with magical powers were worshipped here. Then missionaries visited, the Jesus statue appeared, a miracle was proclaimed, and Chalma became a religious site for Roman Catholics from all around Mexico. Pilgrims from Milpa Alta begin the walk to Chalma on January 3, and the Rejunta meal is a sumptuous quid pro quo for everyone who has donated money, goods, or time to the event.

Virginia is heading to the local offices to get a



Rituals of faith and family

In the morning calm a carpet of decorative sand is strewn along a street in Milpa Alta to celebrate La Rejunta, one in a yearlong series of events leading up to a January pilgrimage. This borough of Mexico City has more than 700 religious fiestas every year.

permit for the procession of icons that will arrive at their house on Sunday. Fermín is driving his black pickup into the countryside in search of dried Indian corn to be ground for atole, a seasonal corn-based drink of chocolate, cinnamon, and vanilla that's nostalgia in a cup for Mexicans. Every step of La Rejunta is a ritual. One year before the event the men go to the forest and collect wood that they pile high near the home of the majordomo so that it will be properly cured before it's used for open-air cooking. Local farmers grow most of the corn, meat, and vegetables needed as ingredients. No instant mixes or other culinary shortcuts are allowed. Food is so central to life in Milpa Alta that it's the currency of exchange for work done, love shared, faith renewed. In this town during the days devoted to La Rejunta, poor people feel rich, and whatever hurt or insult life has dealt is forgotten in a world of bounty.

The volunteers are beginning to arrive, and the majordomos leave their daughter Monserrat Lara Meza in charge. She is a 24-year-old graduate student in biology, but she has put aside her studies to help her parents for the week. She shucks the dried ears of corn and



A prayer before feasting

On the day he succeeds Fermín Lara Jiménez as majordomo, Ernesto Alvarado Salazar prays amid the cauldrons of food prepared for a town celebration. Copal, a tree resin used as incense, wafts from a special brazier used in religious rituals.

tosses them in a wheelbarrow. By midmorning she has covered the patio wall with carefully arranged stacks. "My parents have been in a state of nerves" since their term began, she says while dropping kernels in a basin. Monserrat explains that her parents kicked off their year as majordomos in May 2013 with a big feast under the huge tarpaulin that still hangs over their patio. Tarps and tents go up all the time across Milpa Alta, often in the early evening, as if a circus had come to town. Every year more than 700 religious fiestas are held in the borough of Milpa Alta, which encompasses 12 villages and towns in the rural southeastern corner of Mexico City. The tarps and booming music let everyone know where to find the action.

Fermín and Virginia will pass the mantle to new majordomos, chosen as they were by a special council, when their 12 months are over. Thrilling as it's all been, Monserrat isn't interested in becoming a majordomo herself. Besides, she points out, the waiting list gets longer every year, and all the majordomos have been named through 2046. She wanders down the hill to a shed with a corrugated metal roof to see how the toasting of the corn is going.





MILPA ALTA MEANS "HIGH CORNFIELD," and its identity has been connected to agriculture since pre-Hispanic times. Corn was a primary crop here until the 1930s, when farmers switched to the more drought-resistant nopal, the prickly pear cactus that is a staple of Mexican cuisine. Today the region is one of Mexico's top nopal producers. Another business is the production of *barbacoa*, slowly cooked, barbecued sheep, made the old way, by placing an entire lamb or sheep in a pit of earthen tiles lined with spiky maguey (agave cactus) leaves. Since the town is located about 17 miles from the center of Mexico City, producers can sell to urban dwellers willing to pay top price.

The borough of Milpa Alta is the poorest in Mexico City, with nearly half the local population living below the poverty line. But those born and raised there, like Juan Carlos Loza Jurado, question the significance of the statistic. What is poverty, he asks, when every member of an extended family, employed or unemployed, can count on a meal every day as well as other forms of support? What is poverty when the town hosts a giddy number of festivities over the course of a year? Loza, an academic with a specialty in rural studies, has looked at his community from both a personal and a scholarly vantage point and views its social cohesion as remarkably strong. "People in Milpa Alta have their own perspective. The environment, the kind of social relations they have, these things make their lives better. People say frequently, We are better off here."

That sentiment is borne out by the low level of migration to the United States. Traditional values anchor everyday life, and top among these is eating together.

"In my experience there is a glue, a bonding, that comes from the time together at the table," says Josefina García Jiménez, whose family raises sheep. She often cooks for her nieces and nephews and says, "It feels like I am passing down a tradition, and when it comes their turn to be adults, they will remember what I have done. Here we have time to cook, time to think just what ingredients are needed, time to show your kids through cooking that you love them."

Like many Mexicans, Josefina is a fan of the

Victoria Pope is a former deputy editor of the magazine. Carolyn Drake has photographed groups such as China's Uygurs for National Geographic.



The sisterhood of tamales

On the Saturday before Easter women prepare tamales for a large gathering on Sunday to honor El Señor del Santo Entierro, or the Lord of the Holy Burial, represented by a statue portraying Christ as he lay buried after the Crucifixion.





The drama of the final meal

During Holy Week volunteers reenact the Last Supper in the Church of the Assumption of Maria in Milpa Alta. To evoke authenticity, the table features simply prepared meat instead of more elaborate traditional dishes.



sobremesa—a stretch of time after the meal when the entire family, no excuses, stays seated and talks. It can be the time for shamefaced confessions, laughs, gossip. As a child, Loza soaked up stories at the dinner table about witches known as *nahuales;* his uncles described the nahual's ability to change shape into a donkey, turkey, or dog. At sobremesa came testimony of miracles and omens, of the pilgrimage in earlier times, when men carried supplies to Chalma on horseback. The table is the place where the history of Milpa Alta is passed on.

MARÍA ELEAZAR LABASTIDA ROSAS has bright red braids threaded with dark lavender ribbons. She's stirring a large pot of tamale batter under the watchful, stern gaze of the head cook, Catalina Peña Gómez. Doña Cata, as everyone calls her, attunes her senses to the smell of a sauce, the consistency of a paste, and makes her corrections with the confidence of a general. She won't brook any horsing around where cooking is involved.

Doña Cata is 68, crippled by varicose veins, but she cooks day and night during the final preparations. "I feel love when I cook," she says. Her manner is tough, but she cries a little as she speaks. "I feel love for God. I ask God for help and for the well-being of all my people." She raised four children as an unmarried mother, a status that can be harshly judged in small-town Mexico. Until the pain in her legs forced her to quit, she worked as a cook. Now she lives off the money she makes preparing food for parties. But whatever her social position in the outside world, here, directing the show for La Rejunta, she is a person of authority, a woman who commands respect.

María Eleazar, who is cheerful and energetic, ignores Doña Cata's glare, which she knows is mostly bluff, and continues chatting with the other women, laughing about how Mexican women share recipes with their daughters and daughters-in-law but otherwise jealously guard their culinary secrets. The women trade stories about catastrophes in the kitchen, the result of the wrong mindset. Anger spoils food, they agree. "Cooking must be done with love," says María, stopping to tie her braids together. "There are women who cook without love, and it really doesn't turn out well. If I feel preoccupied, I tell myself, Lock up the problem. And then I cook with love."

For some of these women, food has also been a bridge to the divine power, a part of a heavenly plan. When white-haired Domitila Laguna Ortega spilled a pot of mole sauce that oozed boiling hot over her legs and onto the kitchen floor, she should by all rights have been harmed. But the firemen who came were startled: Why were there no red marks on her body? For Guillermina Suárez Meza, another volunteer, there was a mysterious multiplication of her shrimp soup served to the pilgrims at Chalma. She made large quantities but was convinced she hadn't made enough. "I asked God for the food to last. And it replenished. I gave it with all my soul and all my heart, and it multiplied." Shyly, she casts her amber-colored eyes downward. "Yes, I believe that it could have been a miracle."

BY FRIDAY, FERMÍN HAS CINCHED his waist with a thick leather belt to support his aching back. His vest is speckled with mud. The fires are burning; hundreds of volunteers are fast at work. One of the miracles of this effort is that everyone seems to know his or her part without supervision. They move in a choreography of ease—no one bumps into anyone else, though the workstations are crowded. One of Doña Cata's culinary lieutenants gravely announces to the women making tamales that chili sauce is leaking out of them. Take more care, she scolds.

The cooking is almost done, but Fermín has done the math. More tamales are needed. The troops reassemble. María of the purple ribbons digs her paddle into the thick cornmeal mixture, beating it quickly to add air. Slowly the lumps disappear, and the mixture is transformed into batter. Doña Cata tastes it. Add more lard, she says without hesitation. More salt. It's as if each new teaspoonful is part of

The magazine thanks The Rockefeller Foundation and members of the National Geographic Society for their generous support of this series of articles.



Food on every corner

Many in Milpa Alta work in the food business, growing nopal (prickly pear cactus) or selling barbecued meat or mole sauce. The Triangulo Bakery (above) sells sweet bread, known as *concha* (shell) because of the pattern etched into the loaves.

a ritual that adds a measure of grace, of devotion to God and to one another. The women swaddle the mixture in corn husks and carry the tamales in bins down the hill to the men who will cook them in old oil drums. A straw talisman shaped like a stick man is placed in each drum. The men douse the tamales with tequila or other spirits to ensure good results.

At dawn on Sunday the cooks have crumpled faces, though no one admits to feeling tired. In fact they boast that faith gave them energy to stay up all night. Majordomo Virginia insists that she too feels fine, but it's clear she's been run ragged, her white shirt untucked, her face tense and drawn as she throws logs on the fires under the tamales. When the moment to serve comes, the male cooks stand like sentries and count out a specific number of tamales, calculated to correspond to the amount of money each donor has given. The same is done with the atole, which Doña Cata has stirred all night to avoid any lumps. It's velvet to the tongue. No amount of fatigue would get her to relinquish the job of feeding the crowds that file through all day. "Why would I let someone else take credit for what I have done?"

As she ladles the drink and children cry out in delight, Doña Cata allows herself a smile that spreads into a grin. But she quickly returns to sober-faced focus. There are thousands more cups of atole to serve. And in only a few days the piñatas must be filled with candy for Las Posadas, the nine-day celebration leading up to Christmas Eve. New tarps will dot the town, and the people of Milpa Alta will again yield to the power of food, family, and faith. □

By Their Fridges Ye Shall Know Them

That cartoon cliché of a man standing transfixed before an open refrigerator? That's Mark Menjivar—except he's aiming a camera. For a project Menjivar calls "Refrigerators," the social worker turned photographer makes as-is images of the fridges of people from all walks of life. He captions them obliquely: The midwife, for example, recently vowed to eat only local produce. The street advertiser "lives on $432" a month. The bartender "goes to sleep at 8 a.m. and wakes up at 4 p.m." (leaving little time to eat leftover takeout). Touring exhibits of the actual-size photos, Menjivar says, spark discussion of "not only our personal relationship to food but the larger society's relationship to food systems."



Owned by a midwife and a science teacher



Owned by a football coach and a social worker



Owned by a street advertiser



Owned by a bartender



A fur seal surfs Atlantic swells off Cape Town. To conserve sea life around the city's coastline, a marine protected area (MPA)—one of 23 in South Africa—was created in 2004.



Cross Currents

Southern Africa has some of the world's richest waters. But debate swirls over how to sustain these seas and the fishing communities that depend on them.



Gulls, gannets, and penguins are neighbors on Mercury Island, near the Diamond Coast of Namibia. The country's first MPA aims to reduce human disturbance and increase natural abundance around Mercury and ten other islands along 250 miles of coastline.







Fishermen, conservation authorities, and tourism interests agreed to protect the reefs on one side of Vamizi Island in northern Mozambique and allow fishing on the other. In the fished area, the size and number of parrotfish, triggerfish, and other species are increasing.

By Kennedy Warne
Photographs by Thomas P. Peschak

On Cape Town's western shore, near a big-wave surf spot called Dungeons, is a low, flat island that seals have made their own. They snooze and bellow and nurse pups, and now and then heave themselves into the Atlantic, where snorkelers can join them in their frolics around reefs and through kelp forests. Sunlight sparkles on air bubbles trapped in their fur, and when they somersault and speed away, they trail a champagne wake.

The island lies within the Karbonkelberg Restricted Zone, a "no take" sanctuary inside a much larger protected area that includes most of Cape Town's coastline. Karbonkelberg is the kind of place where a person, enchanted by whiskery seal faces staring into his own, can feel that all's well in the oceanic world.

Unless, as I did, he were to look up and notice a line of men toiling up a hillside path with heavy sacks on their backs. Breaking away from the gymnastic seals, I swam to a tiny cove and stepped ashore onto a carpet of discarded abalone shells. They were the size of soup bowls, and they shimmered with nacreous shades of pink and green, like scenes from an aurora. The air was pungent with the stench of seals and rotting kelp. An ibis stalked among the shells, pecking at scraps of abalone guts. I climbed onto a flat-topped boulder that minutes before had been a shellfish abattoir. Here the men had thumbed the meat out of the shells and filled their sacks.

Up from the cove, through a blaze of wildflowers, the steep zigzag path crosses a ridge to the township of Hangberg. Along this track, the "poachers highway," hundreds of tons of illegal abalone—*perlemoen,* in Afrikaans—are carried each year. The meat enters a supply chain of middlemen and processors, bound for Hong Kong and elsewhere in Asia, where abalone is esteemed as a delicacy and an aphrodisiac.

In South Africa abalone is a synonym for failure: of law enforcement, of fisheries management, and of the social contract that underpins sustainable use of the sea. Abalone is a collapsed fishery, and those who poach it are widely reviled as vultures enriching themselves from the last pickings of a dying resource.

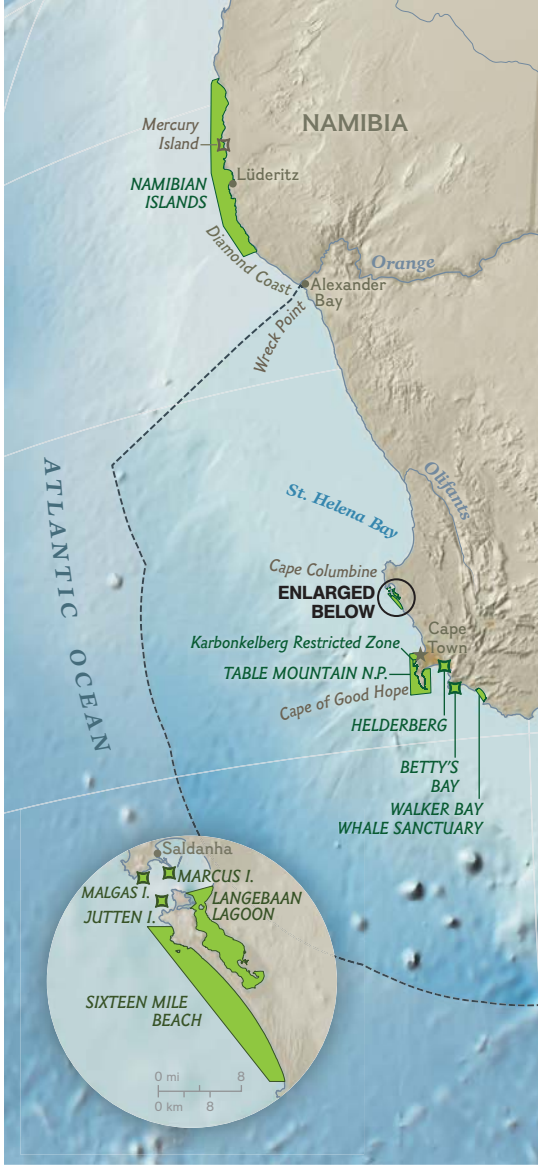
But abalone is part of a wider marine tragedy. Stocks of a third of South Africa's commercially and recreationally caught inshore fish (called linefish, as they are caught primarily with lines) have crashed. In 2000 the government declared a state of emergency and slashed the number of commercial fishing licenses. Yet many stocks remain at perilously low levels—dead fish swimming. Commercial fishing of 40 traditionally important linefish species is prohibited. Even the national fish, a one-foot-long mussel cruncher known as the galjoen, is banned.

In fish-loving, fishing-mad South Africa, the

Kennedy Warne wrote about the southern Line Islands in the September issue. Thomas P. Peschak's book Sharks and People *is about our relationship with the most feared fish in the sea.*



Mercury Island is the most important refuge for endangered bank cormorants, whose numbers have dwindled in recent decades to a few thousand.



anguish of declining catches and vanishing species is acute. But if there's a crisis of fish, there's also a crisis of fishing. Half of South Africa's subsistence fishing communities are described as food insecure, because the foundation of their livelihood is in jeopardy. Yet in 1994, when Nelson Mandela was elected president of newly democratic South Africa, his African National Congress party saw fish as a social equalizer and an uplifter of the impoverished. The rainbow nation would offer its marine resources as an egalitarian pot of gold for all.

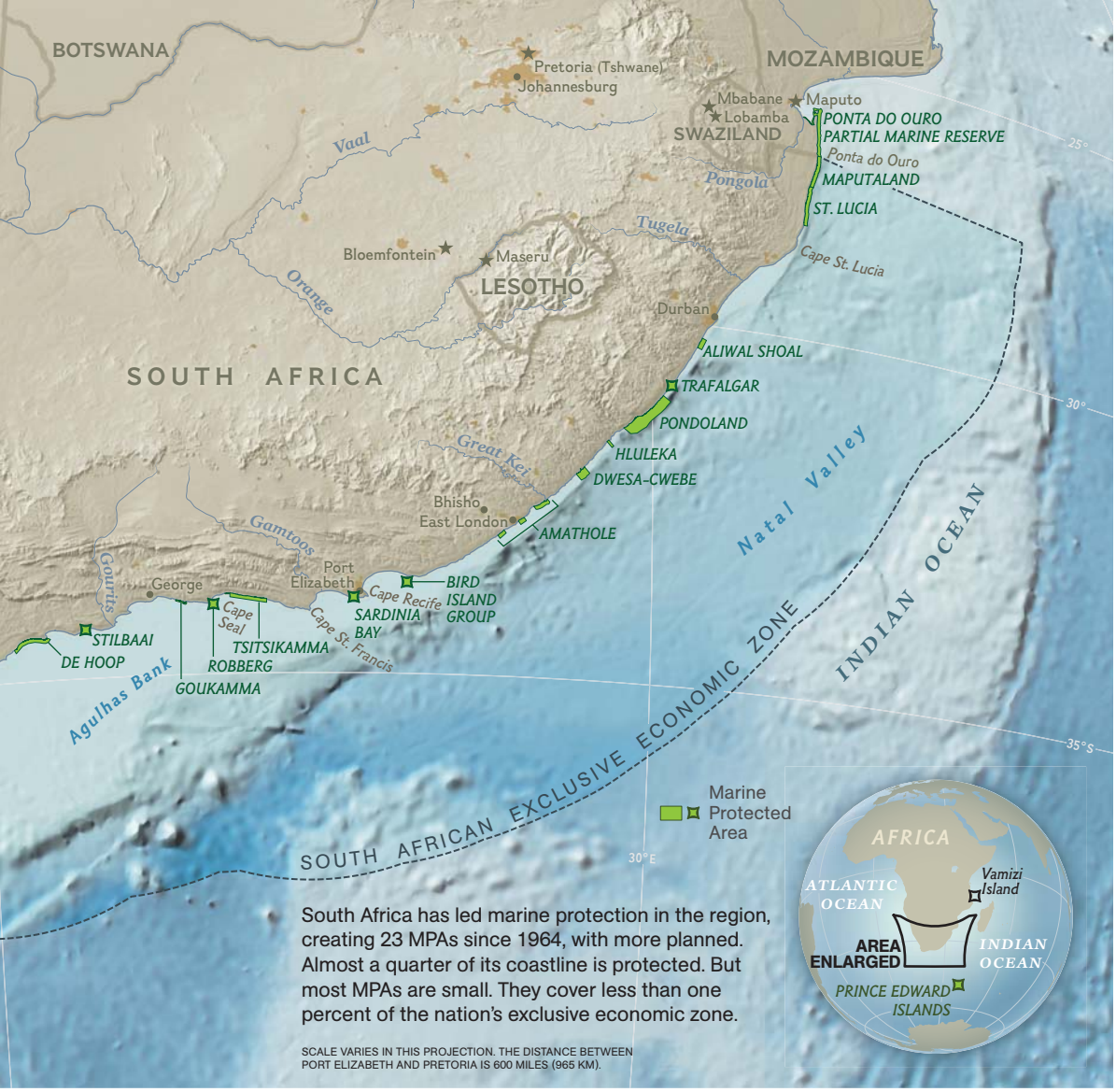
Initially the prospects for social transformation looked good. Thousands of "historically disadvantaged individuals"—black and coloured (the accepted word in South Africa for people of predominantly European-African descent)—obtained fishing rights. By 2004 more than 60 percent of the commercial fishing quota was in the hands of this group, compared with less than one percent ten years earlier.

But as the linefish emergency showed, the government had invited more guests to the buffet than there was food to feed them. Even worse, an entire category of fishermen had been left off the guest list. The new fisheries policy applied to commercial, recreational, and subsistence fishermen, the last group being those who fish only to eat, not to sell. Small-scale or artisanal fishermen weren't included. They were neither strictly subsistence nor fully commercial. More important, they thought of themselves as part of fishing communities, not as individual operators. They sought collective rights and communal access to resources, and they found themselves out of step with a quota system based on privatized ownership.

For these small-scale operators, exclusion from the allocation process felt like a stinging reminder of apartheid. And there was an additional source of alienation, something that in a perfect world would be their best friend: marine protected areas (MPAs), those fragments of coast and seabed that are set aside for either partial or total protection from human exploitation.

MPAs are like oases in a desert. Marine life flourishes within each blue haven and spills over into neighboring areas, enhancing catches and sustaining livelihoods. MPAs are considered indispensable for conserving marine life and managing fisheries, and almost every marine nation has signed a United Nations treaty with the goal of protecting ten percent of the world's oceans by 2020. For many small-scale fishing communities, however, MPAs rub salt in the wounds of inequality—especially if a no-take area lies on the community's doorstep, as it does at Hangberg, where the Karbonkelberg sanctuary includes all the accessible shoreline for miles.

HANGBERG SPRAWLS ACROSS THE SIDE of a hill overlooking the beach suburb of Hout Bay. Above its rickety shacks and bungalows looms a crag



South Africa has led marine protection in the region, creating 23 MPAs since 1964, with more planned. Almost a quarter of its coastline is protected. But most MPAs are small. They cover less than one percent of the nation's exclusive economic zone.

SCALE VARIES IN THIS PROJECTION. THE DISTANCE BETWEEN PORT ELIZABETH AND PRETORIA IS 600 MILES (965 KM).

called the Sentinel. The township has become a place of many sentinels. The poachers employ spotters, who watch out for police officers. Police informers are also watching, pimping on the poachers. A proud community has become a shadowland of crime, protest, and defiance.

I walked through Hangberg's maze of alleys with Donovan van der Heyden, a youth worker, community organizer, and former poacher. Wet suits hung on washing lines, and marijuana smoke drifted over the tin roofs. Van der Heyden, his dreadlocks tucked under a Rastafarian cap, spoke of the community's long memory of dispossession.

"There's a lot of anger," he said. "The community looks back at how much the white fishing industry got from the resource and says, 'Who's the poacher here? You had it. You messed it up. Now that we're claiming our share, we are being blamed for depletion of the resource. But over how many years were you doing the same thing?'

"That's why I became a so-called poacher. It was my way of making a statement about injustice."

The community's feeling of betrayal, he said, sprang from the fact that the government, in its eagerness to open fisheries to new entrants, sidelined bona fide fishermen. "Everyone jumped in—politicians, teachers, lawyers. People quit their professions to get into the industry because it was so open. And now they've got a grip, they're not letting go."

MARTIN GAMACHE, NGM STAFF. SOURCES: GENERAL BATHYMETRIC CHART OF THE OCEANS; DEPARTMENT OF ENVIRONMENTAL AFFAIRS, REPUBLIC OF SOUTH AFRICA



We stopped beside a hole-in-the-wall grocery shop. Purple-leaved bougainvillea spilled over a razor wire fence, and Henry Adams, a swarthy 56-year-old with tattoos on his forearms, came to the gate to talk. For 17 years he had fished up and down the coasts of Africa. But he can't survive fishing in his hometown on his legal recreational permits. "They gave quota to people who don't know the sea," he said. "So now I must poach. Quota made me illegal."

Adams is not an abalone diver. He goes after crayfish—kreef. He rows miles in a night to catch them with small hoop nets. If police come, he hides in the "bamboo"—bull kelp with trunks like baseball bats—where outboard motors can't follow. He has been caught and prosecuted four times. It makes no difference, he said. "I will fish until my dying day, regardless of permits."

A few streets away we came upon a sleek military-gray inflatable. Some young men were replacing the propellers on its two massive outboards. The boat's owner came out of a house. He said he wasn't going to talk to us. To be a successful poacher, he said, you have to "operate like a mouse, softly, quietly." Then he spent the next 20 minutes denouncing the government's fisheries policy.

"I thought when the ANC came into power they would take the white people's large quotas, chop them up into small pieces, and give a piece to each fishing household just to survive," he said. "But what did they do? They played *eenie meenie*



Mozambique's plan to build an industrial port complex within the Ponta do Ouro marine reserve threatens some of southern Africa's richest coral reefs—seen as dark shadows off the coast.

miney moe. If you didn't shout loud enough, you didn't get a quota."

Fishing communities split into factions—established fishing families on one side, opportunists on the other. "It was divide and rule," said van der Heyden, himself a fourth-generation fisherman. "The government fostered the individualistic approach, and as a result the resource suffered and the communities suffered."

If traditional fishermen had been given recognition, he said, they could have worked with the government to set rules for sustainable harvests. Instead, they were bullied and sidelined, and now they feel no sense of ownership. That MPA in their backyard? It's not theirs, it's the state's.

Change is afoot. Communities have begun making the case that closed areas infringe on their constitutional right of access to food. That argument has gained legal and political traction, and pressure is mounting to rezone some MPAs and open no-take areas to fishing.

Marine scientists urge—beg—the government not to do this. If you open one MPA, they say, the rest will fall. Fifty years of fisheries and conservation gains will be wiped out in a matter of months.

IT USED TO BE SAID, "Give a man a fish, and you feed him for a day; teach a man to fish, and you feed him for life." Today a fisheries biologist would add, "But only if you preserve the fish's spawning population." Bruce Mann, a marine scientist whose research helped lead to the establishment of South Africa's largest MPA, Pondoland, in the eastern Cape, explained how protected areas perform that role.

"MPAs function like a bank account," he told me at the Oceanographic Research Institute in Durban. "You invest your money, and you have the security of knowing you've always got it there. But you also get some interest—a little bit of spillover you can live off."

By that logic, fishermen who poach in an MPA are at best squandering their capital, at worst robbing the bank. Why would they do that?

To find out, I drove 80 miles north of Cape Town to Langebaan, a sinuous saltwater lagoon on South Africa's wave-pounded west coast. Langebaan's sheltered marshes, sandbars, and turquoise blue shallows are an important fish nursery and refuge and a feeding habitat for hundreds of species of birds, from falcons to flamingos.

Oom (Uncle) Billie Smith took me fishing for harders, the South African mullet. Harders have been netted here since the 1600s. Most are salted and dried to make *bokkoms*—fish jerky. Oom Billie has fished for them all his life.

A small outboard powered Oom Billie's heavy open dinghy, or bakkie, across the lagoon to a sheltered spot where he payed out his net. It was a calm day, and he wasn't confident of much of a catch. He likes to fish when it's blowing upwards





A prototype electro-magnetic shark-deterring surfboard gets a test run at Aliwal Shoal MPA, near Durban. The device may help manage unwanted encounters between surfers and sharks.







Marine protected areas aim to preserve entire ecosystems, from plankton to predators. At Ponta do Ouro, in southern Mozambique, healthy reefs ensure the annual return of schools of migratory baitfish, which attract predators such as the venomous lionfish (above). Wide-ranging pelagic species such as tuna (top left, shot by a spearfisher near Aliwal Shoal), some sharks, and many marine mammals and seabirds derive little value from small coastal protected areas, especially where fishing is allowed. They would benefit from offshore MPAs large enough to protect important spawning or gathering areas, but industrial fishing, mining, and fossil fuel enterprises have opposed such protected areas. Many African communities have deep ties to the sea, and traditional healers (left) often perform rituals and ceremonies at the water's edge.

of 35 knots—conditions that keep recreational boats off the water and stir up the bottom, providing food for the fish. After half an hour, he pulled the net in. We had three small harders. Cormorants had taken another two.

That was it for fishing. We motored around the lagoon, and Oom Billie named every rock, point, bay, and reef we passed. I had heard it said that Langebaaners can navigate their lagoon blindfolded. But their world has changed utterly. With a casino at one end and seaside mansions choking the cliffs at the other, Langebaan has become a resort, and the sea a playground for the rich, not a workplace for the poor.

Oom Billie pointed to properties on the Langebaan shorefront that the community had owned before apartheid came. Then a line was drawn—white people to the south, coloured people to the north—and a community was upended.

Now there are lines in the sea. In 1985 an MPA was created, and the lagoon was partitioned into three zones. The fishermen are permitted to cast their nets only in a recreational zone adjacent to the town, which they must share with up to 400 powerboats and an armada of kiteboards and Jet Skis. They say that all this traffic drives schooling harders into the two-thirds of the lagoon where they are not allowed to fish.

To the fishing community, the MPA looks like another kind of forced removal. Not a symbol of promise—nature's bank, with interest payments for all—but a continuing sentence of exclusion and denial.

I joined a group of fishermen at the home of Solene Smith, a community leader. They were sardined into a strip of shade behind the house, talking and passing a bottle. It was Sunday, drinking day. The firewater flowed, tears flowed, and the fire in their voices flamed. One of them was about to face prosecution for fishing in the restricted zone. He would most likely have his boat and gear confiscated. But this would not stop the fishermen from trespassing to catch mullet. They refuse to accept the legitimacy of the zoning divisions, and they dispute the government's assessments of fish stocks. By their reckoning, they are not robbing the bank but exerting their rights—not just as customers but as foundation shareholders.

Did the maritime authorities talk to them about zoning, or how best to manage the lagoon? I asked. Did the marine scientists ask them to share their knowledge? *"Nooit!"* they said. "Never!"

Smith was wearing a sea blue T-shirt with the slogan, "Unite and fight for fishers' rights."

In fish-loving, fishing-mad South Africa, the anguish of declining catches is acute.

Solidarity has emboldened the small-scale fishermen, and recent legal victories have strengthened their cause. Courts have upheld the customary rights of traditional fishing communities and required the government to modify its fisheries legislation to allow a community-based approach to managing marine resources.

Many marine scientists view these developments with dismay. "Just as we're trying to reach conservation targets and open new protected areas, existing MPAs are being put on the chopping block," Mann told me. He and others have been working on an MPA expansion strategy that aims to have 15 percent of the country's total marine territory under no-take protection by 2028—"an ambitious goal for any maritime nation," he said. But under current conditions it is like trying to lay railroad tracks while behind you people are tearing up the rails and selling them for scrap. Even venerable Tsitsikamma, the country's first marine reserve, created in 1964, is under threat, despite its importance as a population backstop for several linefish species.

"We've tried very hard to reduce fishing

effort on many of our species because we knew we were fishing them too hard," Mann went on. "Suddenly now with equity redress we're putting pressure straight back onto those resources. Yes, people are hurting. They're hungry and need food. But these fishers will be harvesting what we've managed to claw back over four decades, and it's going to get flattened in a very short time. It's terribly complicated and emotional."

For scientists as well as fishermen: The scientists feel sick at the thought of MPAs being opened, and the fishermen feel sick at the thought of them staying closed.

Could cooperative fisheries management—the state working in partnership with the communities—thread the needle between ecological protection and social justice? A new small-scale fisheries policy released by the government in 2012 claims to be a paradigm shift in that direction: governance from the bottom up rather than imposed from the top down. The policy will give small-scale fishermen the communal rights they crave, along with preferential access to marine resources. But will it resolve the problem of too many fishermen and too few fish?

OF ONE THING MARINE SCIENTISTS are certain: There will be no fish for tomorrow without protection today. And there is much more to protect. Forty percent of South Africa's marine and coastal habitats are not represented in the MPA network, and no MPAs have yet been established offshore, in the vast hinterland that has been called the "heart and lungs" of the ocean.

"We cannot do without no-take MPAs," Mann said. "They are our last resort." They not only are ecological refuges and fish banks, but they provide benchmarks and baselines as well. They reveal the default settings of the ocean. And they may be the last place to see species that have been harried to the point of extinction.

One such species is red steenbras, a premier game fish that in 2012 was added to the prohibited-catch list. These giant bream were a South African angling institution. Up to six feet long and 150 pounds, capable of severing the fingers of unwary fishermen with their jaws, they were exciting to catch, delicious to eat, and as plentiful as the stars in the southern sky. Now, incredibly, they are almost gone.

I learned that there was a resident red steenbras at Castle Rocks marine reserve, beside the hook of land that is Cape Peninsula, so one morning I went there to look. I knelt on the seafloor while ocean swells swayed the kelp fronds and soft corals like an undersea wind. There were fish everywhere. Cape knifejaw and galjoen flitted through the kelp canopy like birds in a rain forest. Broad-shouldered romans, brick red with spatterings of white, muscled in close, and dainty French madames pecked at the bait I held, as if nibbling a madeleine.

A leopard catshark wriggled under a ledge inches away. I slipped my hands under it and lifted it out. It lay as straight and still as a baguette. I laid it back under the ledge and watched it scuffle away. My dive partner tapped my shoulder and pointed, and here came "Rupert," finning through the crowd. Red steenbras are now so rare that divers have given them names. Rupert had been named after its species, *rupestris.* Though not one of the six-footers of yore, it was still an impressive fish, with gleaming bronze flanks and the angular snout of a high-speed train.

If people could just see this, I thought. If politicians, fishermen, and fisheries managers could witness such abundance, they would understand that MPAs are essential for flourishing seas. Alone, they are not enough. Without just policies about who can fish, and where, sustainable fisheries are an illusion. But when fishermen embrace marine protection and decision-makers honor fishing traditions, an old paradox can be solved: having our fish and eating them too. ▯

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Caught Between Two Worlds

In Kosi Bay, near South Africa's border with Mozambique, people have used fish traps for centuries. Can this tradition withstand modern market pressures and a surge of newcomers?

VIDEO





Whales, dolphins, seabirds, seals, and sharks—such as these coppers—follow South Africa's annual sardine run northeast, along the Indian Ocean coastline. The run is a reminder of the ocean's onetime plenitude—and a call to action on behalf of threatened seas.



OUT OF EDEN WALK · PART THREE

Blessed.



Cursed. Claimed.

ON FOOT THROUGH THE HOLY LANDS



Arab Christians in Jordan hike to pray beneath a cross during Feast of Epiphany week near the banks of the Jordan River.





Over cups of tea and puffs on a hookah, Bedouin tourist guides keep company with the past in the Jordanian desert. A phone shows a picture of Auda Abu Tayi, legendary ally of Lawrence of Arabia.

By Paul Salopek
Photographs by John Stanmeyer



Jerusalem is not a city of war. Avner Goren is stubborn on this point.

We are on foot, walking under a cloudless morning sky in the Levant, following a river of raw sewage that foams in torrents from East Jerusalem—12 million gallons a day, Goren informs me—a foul discharge that runs for 23 miles down to the Dead Sea. We are trailing the waste as a form of pilgrimage. Goren, one of Israel's leading archaeologists, thinks like this.

"There have been 700 conflicts here since Jerusalem was founded," he says over his shoulder, wedging his way through religious tourists in the Old City. "But there were long times without war too. And people lived peacefully together."

There are three of us.

Goren: a native Jerusalemite, a tousle-headed intellectual with the watery blue eyes of a dreamer, and a Jew. Bassam Almohor: a Palestinian friend and photographer, a tireless walking guide from the West Bank. I join them both after trekking north over the course of 381 days from Africa, out of the biological cradle of humankind in the Rift Valley of Ethiopia, and into the rise of agriculture, the invention of written language, the birthplace of supreme deities: the Fertile Crescent. My slow journey is part of a project called the Out of Eden Walk, whose aim is to retrace, step-by-step, the pathways of the Stone Age ancestors who discovered our world. I plan to ramble for seven years to the last corner of the Earth reached by our species: the southernmost tip of South America. When I describe my trajectory to Goren, he replies, "Yes. You've come up from the south, like Abraham."



Dark suits and beards predominate in Mea Shearim, a Jerusalem enclave of ultra-Orthodox Haredi Jews. The sexes are kept separate in many public activities, from eating to worship, in a district little changed since its settlement in 1874.



For almost two years, the Out of Eden Walk project, which traces the global spread of early humans, has taken Paul Salopek from Africa's Great Rift Valley to the Middle East, birthplace of cities and agriculture.

Contested Ground

On this stretch of his journey, Salopek left the "oceanic vistas of Arabia" to trek the ancient corridor of the Jordan River Valley to Jerusalem and the West Bank, a route long the focus of conquest and conversion.

Our sewage walk—Goren's grand idea—is as compelling as it is eccentric: He wants to clean up the waste (Germany has promised support for a wastewater treatment plant) and establish miles of "green" trails along a fabled valley where 5,000 years ago Jerusalem was founded. These walking paths would unspool from the spiritual core of the Old City through the biblical desert, where the pollution oozes under a yellow sun. Because the effluent crosses the separation barrier between Israel and the West Bank, such a route would bridge the lives of Palestinians and Israelis. The purified river, by collecting in its arid watershed the sacred and profane, would help build peace between the Middle East's two archenemies.

"This pilgrimage will be different on many levels," Goren says. "It follows an important cultural and religious corridor, true. But it also connects Palestinians and Israelis in a very real way. And of course there is the clean water."

We start among the shrines of the three Abrahamic faiths: the Dome of the Rock, the spires of the Church of the Holy Sepulchre, and the towering blocks of the Western Wall, bristling with prayers inked on paper. We sweat down shadeless streets in Palestinian neighborhoods. We follow the sludge through barren hills, where it encircles a sixth-century monastery like a grim moat. The effluent slides through an army firing

RYAN MORRIS, NGM STAFF



Striding toward Bethlehem, in the West Bank, Salopek is detoured by a herder's tattered fence, one of the first human-made barriers—other than checkpoints and border gates—he's faced in some 2,300 miles since he started out in Ethiopia.

range. In airless canyons we breathe through our mouths to blunt its stench. Two days later we reach the terminus: the salt sea between Israel and Jordan.

"Monotheism was born here," Goren tells me atop a cliff overlooking the sheet of iron-colored water. "Once we invented agriculture, we didn't need nymphs at every spring anymore. The old gods of wild nature were no longer required."

Only ultimate mysteries remained.

It seems so impossible, so unworkable, so naive, Goren's dream. (Weeks later, yet another round of Palestinian-Israeli fighting would flare. Rockets would scratch the skies. Israel would invade nearby Gaza. "This will set me back by two years," Goren would sigh. "But I'll wait.") This is how we must have advanced, originally, across the dawn world. Against laughable odds. Across 2,500 generations of setbacks, despair, blows, crises of faith.

Yet surely it is the quest that matters.

WE WALK NORTH, Hamoudi Alweijah al Bedul and I, from the Saudi Arabian border. We climb the brow of Syria.

What is the brow of Syria?

A rampart of rock: a colossal knuckle of

National Geographic Fellow Paul Salopek is a former staff writer and foreign correspondent with the Chicago Tribune. *To read his online dispatches from the trail and post your comments, visit* nationalgeographic.com/edenwalk. *Follow on Twitter:* @outofedenwalk. *John Stanmeyer, a longtime contributor, is documenting portions of Salopek's walk for the magazine.*





Youths explore Roman ruins at Samaria-Sebaste, a West Bank archaeological site divided between Israeli and Palestinian control. A forum and a temple to Augustus remain from the pre-Christian Roman city.



Members of the Ethiopian Orthodox Church rejoice in a dousing of holy water during Easter Week in Jerusalem's Old City. More than a hundred thousand Ethiopians have immigrated to Israel since 1948.





Stylized carvings of camels, one with a rider aboard (at left), are among the thousands of petroglyphs and inscriptions left by travelers over 2,500 years or more in Wadi Hafir, a narrow, boulder-strewn canyon in southern Jordan.

sandstone punching up from the Hisma, the pale frontier plains of south Jordan. Arab mapmakers of the Middle Ages drew this high barrier as an edge, a fulcrum point, a divide. To the south, the vast geometrical deserts of Arabian nomads, a redoubt of feral movement, of fickle winds, of open space, of saddle leather—home to the wild Bedouin tribes. To the north, the lusher, more coveted fields of settled peoples, of walled civilizations, of layered borders drawn and scratched out—the many-chambered heart of the Levant. We walk into the Fertile Crescent, the prime incubator of human change. A cockpit of empires. A palimpsest of trade roads. A place of exile and sacrifice. Of jealous gods. The oldest of promised lands.

Hamoudi, my guide, sings his way uphill. He leads a pack mule by a chain, bowed against an icy wind. His faded kaffiyeh snaps like a flag. I walk ahead, pulling another loaded mule. Hamoudi steers me too, like a dumb beast. "Left!" he cries in Arabic. "Right!" And "No, no, straight ahead!" In three days of walking together, my Bedouin traveling companion and I pass life-size Neolithic bulls etched into rocks at Wadi Rum, a fabulous corridor of tangerine sand—a primordial valve of human migration that T. E. Lawrence called a "processional way greater than imagination." We trace our fingers over 2,000-year-old inscriptions pecked by Nabataean incense traders and nomadic herders. We stagger over rubble from Roman forts. We camp beside ruined churches of Byzantium—the eastern Christian empire—their naves caved in, roofed now by desert skies marbled with cirrus. Everywhere we spot the prayers carved

by long-dead Muslim pilgrims walking south to Mecca.

The storm belts us on the rim of the Jordan Valley. Gusts chuck up fistfuls of dirt. The mules moan. Deranged by lightning, a hobbled camel lopes past screaming like some mocking portent, only to vanish in the gloom. Bedouin women refuse us shelter. In violet twilight they warn us away, shouting objections from the interiors of their belled and tottering tents. Night falls. We walk on.

"Palestine," Hamoudi tells three lean, unshaven, deeply filthy sheepherders of the Sayadeen tribe who finally take us in. It's as good a destination as any.

The shepherds stir the cherry embers of their hearth. They accept our instant coffee sweetened with condensed milk, sipping from plastic cups with pinkies held out like lords. They ask politely after our well-being. They praise God that we are content. My feet are frozen. Hamoudi winks and grins. He will sleep with his dagger on a rug of sand. Tomorrow is Christmas.

HUMANKIND PAUSED, mid-step, while ambling through the Middle East. Wolfish bands of hunter-gatherers, weary from 200,000 years of wandering, sat down in the chalky valleys of the Levant. They sought out reliable springs of sweet water. They learned to sow wild grasses—barley, emmer wheat, flax. They tamed wild oxen with horns six feet wide. The nomadic imperative of hunting was set aside forever. Instead these newly settled peoples began stacking stone upon stone, building the first villages, towns, cities. Smelted metal appeared. So did commerce and armies. A new world entire, bustled, unfolded, expanded—one we still inhabit. This "Neolithic revolution" occurred between 9,000 and 11,000 years ago. It erupted, independently, in the earliest agricultural societies in China, Mesoamerica, and Melanesia. But it bloomed first in the rumpled dun hills and forested riverbanks along our route out of Africa.

Or so say the textbooks.

Hamoudi and I trudge 300 miles north through the lavender shadows of the Transjordan range. We tug our hammer-headed mules along the tourist trails of Petra, the fabled Nabataean capital cut from rock the color of living muscle. We walk past Bronze Age graveyards that contain dead so old and unloved they hardly seem human anymore—Fayfa and Bab edh Dhra, the famous boneyards of the sort that some biblical scholars link to the destroyed cities in Genesis, Sodom and Gomorrah. Wadi Faynan 16 holds no such notoriety.

Discovered in 1996, the site sits atop a remote gravel terrace above the gaunt and dusty Jordan River Valley. This obscure site is an enigma, a paradox. It upends the usual narratives of human progress. Circular dwellings, grinding stones, stone tools—its village relics date back an astonishing 12,000 years, deep into our nomadic Stone Age. The people who settled here weren't farmers. They hunted. Yet they built a large amphitheater of mud, a platform carefully runneled to carry liquid—possibly blood. They came, apparently, to witness some ritual. To pray. And like Göbekli Tepe in Turkey, another profoundly antique cultic monument that has gained worldwide fame, Wadi Faynan 16 suggests that organized religion—spiritual hunger, not empty bellies—may finally have stopped our ramblings, kindled our urbanism, made us modern.

Hamoudi leads a pack mule by a chain, bowed against an icy wind. He steers me too, like a dumb beast. "Left!" he cries in Arabic.

"The amphitheater looks designed for communal worship," says Mohammad Dafalla, an archaeological guide who helped dig up



A young Syrian refugee gets an airlift while others stick to the back-bending work of picking tomatoes in Jordan, now home to more than half a million Syrians fleeing the bloody civil war.





Carl James Joseph—an American known as the Jesus Guy for his emulation of the Savior—beds down in Jerusalem's Old City with only a blanket and a Bible. Christian pilgrims have been following Jesus' footsteps since the fourth century.





Faynan 16. "Something very old ended here. Something new began."

Hamoudi gathers twigs for a campfire. The Jordan Valley sprawls below in a broth of yellow light: a vast and barren causeway trodden by the feet of prophets. By Abraham and Moses. By Jesus and John the Baptist. Early humans strode past out of Africa nearly two million years ago, earlier probably. Hippos, now extinct, grazed in the valley's vanished swamps. Yesterday the walls of Jericho came tumbling down. Not an inch of this antique vista hasn't been fought over, cursed, blessed, claimed for one divinity or another. It is a land worn smooth like a coin traded through countless fingers.

Hamoudi boils a pot of tea. We squint from the first house of god through a hot desert wind, down at the Holy Land's novel idea: home.

A MIRACULOUS DESERT RAIN. We slog, dripping, into As Safi, Jordan. We drive the sodden mules through wet streets. To the town's only landmark. To the "Museum at the Lowest Place on Earth."

This whitewashed building sits near the Dead Sea, exactly 1,329 feet below sea level. Inside its exhibit hall, behind panes of glass, in a white-lit lab, a team of restorers works on an ancient Byzantine floor: 44 square yards of stone shards rescued from Lot's Cave Monastery. (Lot: the Old Testament refugee from Sodom.) The floor dates from the fifth century A.D. and contains 300,000 jumbled tesserae in hues of red, brown, yellow, olive green, and white. Greek, Australian, and Jordanian experts have gathered here to piece the small stone cubes back into a whole. They have been doing this for 14 years.

In the irrigated fields of As Safi, Syrian refugees survive hand to mouth, picking tomatoes for $11 a day.

Stefania Chlouveraki, the project leader, stands at a long sorting table. She turns the colored fragments over and over in her fingertips. She fits each one into its place: a magnificent tableau of lions, crosses, pomegranate trees.

"There's a trick to it," Chlouveraki says. "One



Prayers fill the air along the 42-yard length of the men's section of the Western Wall, in the prayer plaza in Jerusalem, the holiest site in Judaism. The stones are all that's left of the Second Jewish Temple, destroyed by the Romans in A.D. 70.

small piece can bring a whole section together."

Chlouveraki, a tenacious archaeological conservator, has salvaged antiquities all over the Middle East. There is so much history here—so much that needs to be preserved, documented, rescued. Chlouveraki is particularly fond of the neighboring country of Syria. She has many friends in the old Syrian city of Hamah, a major cultural hub. She worries about them—about their safety. Much of that city has been destroyed by the Assad dictatorship in Syria's brutal civil war. She doubts she will ever see Hamah again. Yet she is wrong. Because Hamah is all around her.

Hundreds of thousands of Syrians shelter beneath UN canvas in Jordan. In the irrigated fields of As Safi, these refugees survive hand to mouth, picking tomatoes for $11 a day. We have been staying with them, Hamoudi and I, almost every night. It is remarkable. All are from Hamah. An entire metropolis has taken to its heels, walked away from apocalypse, spilled across borders, over mountain passes, to scatter in the Jordan Valley. The women bring out delicate tea sets saved from blown-up houses. They pin fine Syrian embroideries, called *sarma,* inside their dusty tents as reminders of home. Their faces, as they remember their dead, become sadly luminous.

Such is the deeper mosaic of the Levant. Here, long ago, we invented cities. Here we scatter again from war, like broken tesserae, back into nomadism.

THE HOLY LAND IS COVETED. It is profoundly walled. Few outsiders realize to what extent.

In Amman, at the banks of the Jordan River between Jordan and the Israeli-occupied West Bank, people gather for Epiphany. This is a New Year's rite for Orthodox Christian believers. The faithful come to the sacred stream to sing hymns, to be rebaptized. They also exchange shouted greetings across five yards of sliding brown water: "How is Auntie?" "Hold up the baby!" And "Tell Mariam we will call her tonight!"

These are Christian Arab families divided by the 1967 war between Israel and its Arab neighbors. A striped metal pole, almost within arm's reach of each shoreline, juts mid-current above the water, delineating the border. Israeli soldiers in olive fatigues and Jordanian police in navy blue stand ready to halt anyone who might dare wade across it. A few days later I ford the Jordan River on a bus: Foot travel across Allenby Bridge checkpoint is strictly prohibited.

"Checkpoints. Checkpoints. Checkpoints," Bassam Almohor tells me. "We have checkpoints in our minds. We wouldn't even know what to do with free movement."



Muslims from India pray alongside Jews at King David's Tomb, on Mount Zion in Jerusalem, one of the few places in Israel where members of the two faiths worship together. A synagogue, a mosque, and a Crusader church have all occupied the site.



Almohor is middle-aged, a storyteller. He is a compulsive walker, a Palestinian who expects the worst in life in order to be pleasantly surprised—a relisher of irony. Over the course of two sweltering days of rambling the West Bank, we squeeze through a thicket of visible and imaginary borders, fences, walls, frontiers, barriers, no-go zones. After a year steeped in the oceanic vistas of Arabia, of Africa, such a dicing of landscape into countless micro-turfs makes me dizzy. My head spins.

Smaller than Delaware, packed with 2.7 million people, the core of a proposed future Palestinian state, the occupied West Bank is partitioned by the Oslo Accords into zones of Palestinian and Israeli control: Areas A, B, and C. Each of the zones has its own restrictions, guidelines, regulations. A political map of the territory looks like an x-ray: a diseased heart, mottled, speckled, clotted, hollowed out. We inch past Hisham's Palace, in Jericho, a little-visited treasure of eighth-century Islamic art (Area A). Sweating under the sun, we scale the barren eastern scarp of the Great Rift Valley (Area B), edging carefully around controversial, razor-wired Israeli settlements (Area C). Plodding 26 miles on through a nature reserve and an Israeli artillery range (Area C again), we collapse in Bethlehem (back in Area A).

A line of clocks in our cheap hotel displays the time in Lagos, Bucharest, Kiev: the capitals of pilgrims who come to kneel at the birthplace of Christ. In reality the entire world funnels through the Church of the Nativity. The next morning, on blistered feet, Almohor and I join long lines of Argentines, of Russians, of Americans, of French. In clouds of incense, they lay their palms on flesh-polished stones where the Godhead touched Earth.

A medieval Greek Orthodox church controls access to the grotto of the manger. Next door a newer Roman Catholic cathedral makes do with a peephole. Catholic visitors peer through this hole into the yellowed light of the holy birthplace. The hole is big enough, I note by testing, to admit my pencil. Here is a classic West Bank arrangement: a celestial Oslo Accord.


n East



Orthodox Christian pilgrims from eastern Europe exult in having their candles lit with “holy fire,” believed to emanate on the day before Easter from the site of Jesus’ tomb, in Jerusalem’s Church of the Holy Sepulchre.



Salopek's walk brought him near the Rosh HaNiqra grottoes in northern Israel, at the border with Lebanon. From the Mediterranean shore he will aim north and then east into Eurasia, as the earliest human travelers did.

SEE THE MEN DANCE. Arms draped on shoulders, kick-stepping in circles, they swing bottles of wine. Purpled thumbs cork the bottles. The wine leaps and jumps behind green glass. They throw back their heads, the dancing men. They laugh at the sky. They are happy. They lurch into streets. They reel among cars to the blare of horns. On the sidewalks their children walk, oddly attired—a carnival of pygmy soldiers, ninja, geisha, Roman centurions.

"Everything we hate," one man explains in broken English. He means sin. Laughing, he dances on.

He is Haredi, a member of the conservative Jewish sect that rejects modern secular culture. Bene Beraq—a low-income, ultra-Orthodox satellite of Tel Aviv—broils on the Mediterranean plain of Israel. Its male residents dress like crows: heavy black suits, black Borsalino hats, the old grandfathers hugely whiskered and the boys in *peot,* the curled sidelocks of the pious. The women pale and staring under the sun. In plain skirts, drab shoes. In hair scarves. Their drunken revelry jars. A fiesta of Quakers. An imams' jamboree. A bacchanal of Mennonites.

These godly folk—have they gone mad?

No. It is simply this: After walking the time-worn horizons out of Africa, I have entered a corrugated maze, a knotted crossroad of the world where landscape is read like sacrament, a labyrinth of echoing faiths called the Middle East. The strange zeal at Bene Beraq is a festival of joy, of survival: Purim. Purim commemorates the deliverance of the Jews from a genocide under the Persians almost 2,500 years ago. That slaughter, plotted by the courtier Haman,

was foiled by two brave Jews, Esther and her stepfather, Mordecai. Every 14th day of Adar, Jews celebrate their continued existence. They exchange gifts. They make themselves "fragrant with wine." They drink until they "cannot tell the difference between 'Cursed be Haman!' and 'Blessed be Mordecai!'" It is a holiday one feels one can get behind.

I join in. Unkempt, in threadbare clothes, with holed shoes and sun-cured hide, my costume is permanent: the traveler, the man from far away. At Bene Beraq the masked children laugh. They ask for coins.

My walk is a dance.

After walking the timeworn horizons out of Africa, I have entered a corrugated maze, where landscape is read like sacrament.

The anthropologist Melvin Konner writes how the *num* masters of the Kung San, the shamans of the Kalahari—members of perhaps the oldest human population on the planet—induce a spiritual trance through hours of dancing around campfires. Such arduous rituals deliver up to 60,000 rhythmic jolts—the number of footfalls in a long day's trekking—to the base of their skulls. The result, Konner says, is a psychological state that we have been questing for since our species' first dawn, "that 'oceanic' feeling of oneness with the world."

This may explain the neurology of rapture. But why the pursuit of it?

I WILL EXIT THE CAULDRON of the Levant at the Israeli port of Haifa. I buy passage on a cargo ship that will carry me around the abattoir of Syria to Cyprus. From there, it's on to Turkey.

One day's walk south of Haifa gape the Mount Carmel caves. They hold *Homo sapiens* bones a hundred thousand years old. This famous archaeological site marks the farthest limit of human migration out of Africa in the middle Stone Age—the outer edge of our knowledge of the cosmos. I trudge to the caves in a squall. The government has seen fit to prop mannequins inside these rock shelters: plaster cave people dressed in skins. In gray stormy light, their painted eyes stare out at the Mediterranean—at Homer's wine-dark sea, at a corridor into modernity. But in memory my walk's true coda in the Middle East came earlier.

I had camped months before, on the shore of the Dead Sea, with a family of Bedouin.

The father, Ali Salam, was poor. He gathered aluminum cans alongside the highway. His teenage wife, Fatimah, a shy, smiling girl in a filthy gown, rocked her sick baby under a plastic tarp. She cooked tomatoes pilfered from nearby fields. We ate from a sooty cook pot. Across the asphalt, not 200 yards away in the night, blazed a pod of luxury resorts. I imagined, back then, another couple standing behind plate glass windows: Glasses of minibar wine in their hands, they might have stared out into the dark. Did they see our campfire? Could they hear the child's persistent cough? Of course not. I tried to resent them. But they weren't bad, the people in that well-lit room. Certainly no worse or better than anyone else traveling the lonesome desert road. Such was the walk's only theology. The Bedouin. The people in the hotel. The road that divided and united them. ▯

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MULTIMEDIA

Jerusalem Guided Tour

Walk with Paul Salopek through the city of Jerusalem—a 23-mile journey that transgresses multiple boundaries, both real and imagined.

VIDEO

The passion and toughness of the people who live here unite them more than they know.

—PAUL SALOPEK



JUST PRESS PRINT

AS EPOCH-MAKING AS GUTENBERG'S PRINTING PRESS, 3-D PRINTING IS CHANGING THE SHAPE OF THE FUTURE.



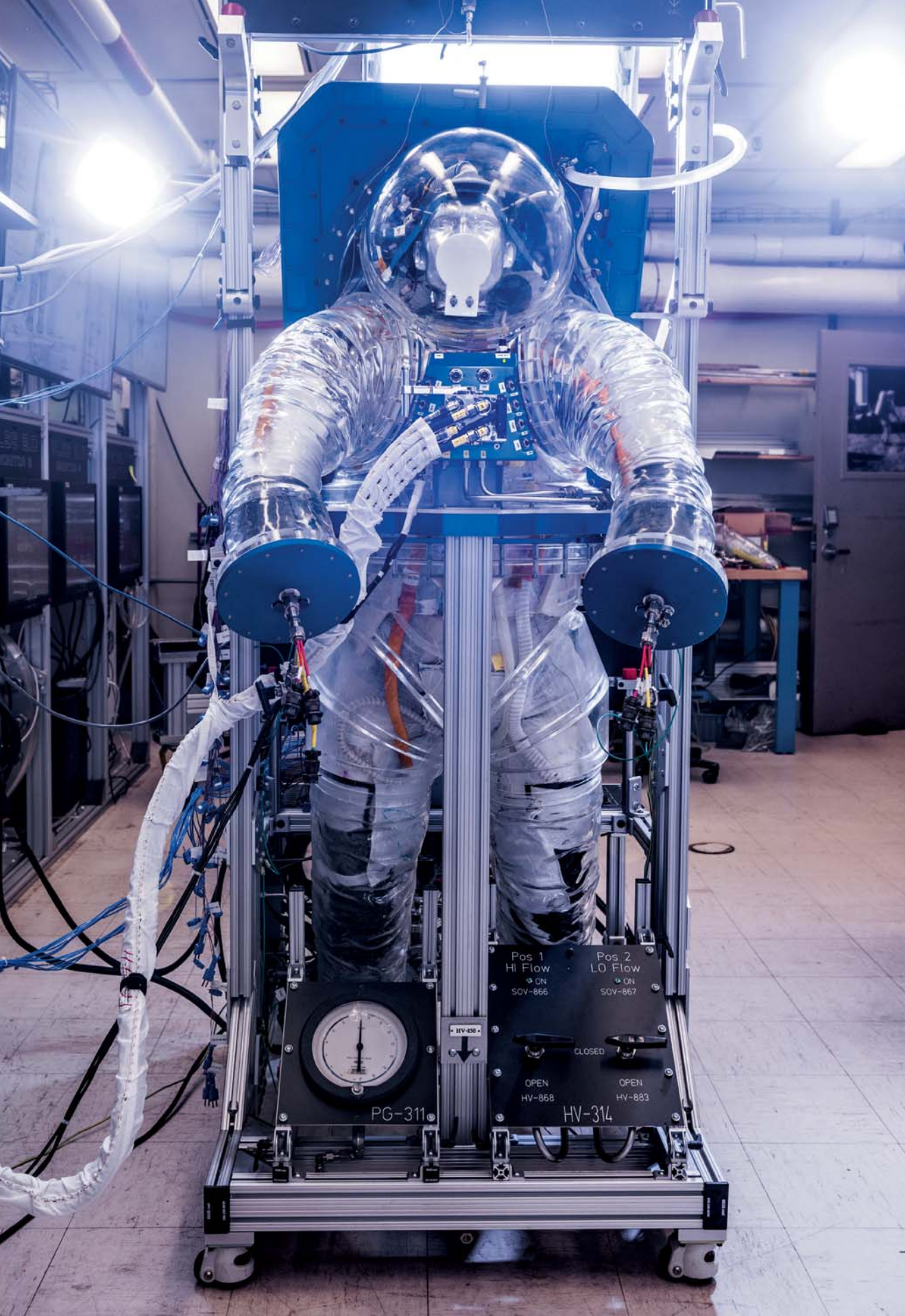
A bionic ear printed by researchers at Princeton University uses "inks" made of silicone and chondrocytes, cells that produce cartilage. The metal coil receives and transmits electrical impulses, which could stimulate the auditory nerve, as a cochlear implant does.

PHOTO: FRANK WOJCIECHOWSKI
SOURCE: MICHAEL McALPINE, PRINCETON UNIVERSITY



This detailed, life-size replica of King Tutankhamun (right) was printed in a clear polymer using CT scans of the actual mummy and later sculpted and painted to resemble desiccated flesh. NASA is using a space suit simulator (far right), made in part with 3-D printed molds, to test a design for a portable life support system.

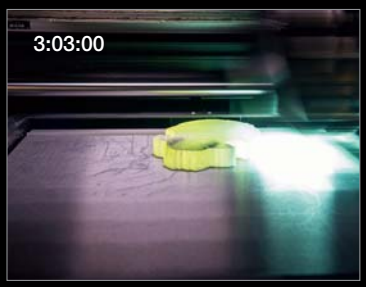
SOURCE: PREMIER EXHIBITIONS (RIGHT)

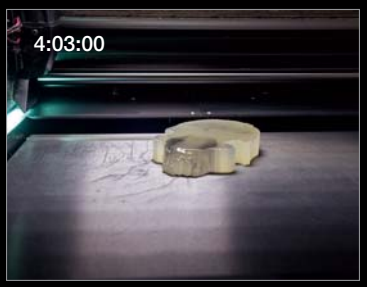

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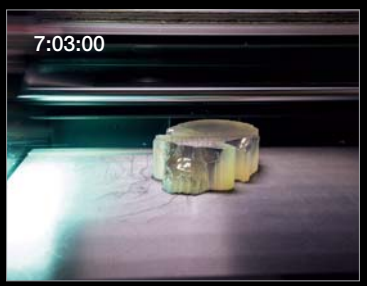

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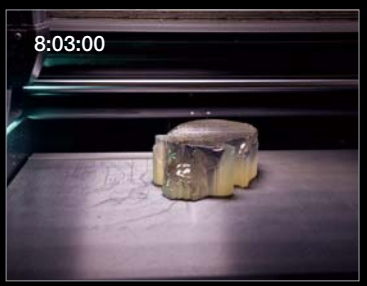

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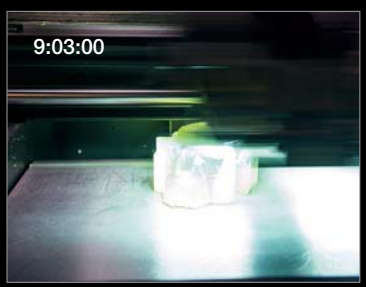

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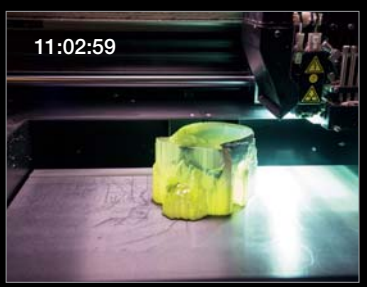

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A replica of a 1.9-million-year-old *Homo habilis* skull made with a polymer resin emerges over 15 hours on a 3-D printer. The Turkana Basin Institute and the National Museums of Kenya teamed up with a software firm to create *africanfossils.org* to showcase many of the iconic fossils discovered in East Africa. Files to print 3-D copies for educational purposes can be downloaded from the site.

SKULL DIGITIZED AND PRINTED BY AUTODESK



By Roff Smith
Photographs by Robert Clark

Rocket engine parts, chocolate figurines, functional replica pistols, a Dutch canal house, designer sunglasses, a zippy two-seater car, a rowboat, a prototype bionic ear, pizzas—hardly a week goes by without a startling tour de force in the rapidly evolving technology of three-dimensional printing.

What sounds like something out of *Star Trek*—the starship's replicator could synthesize anything—is increasingly becoming a reality. Indeed, NASA is testing a 3-D printer on the International Space Station to see if it might provide a way to fabricate meals, tools, and replacement parts on long missions.

Back on Earth, long-term business plans are being reimagined. Airbus envisions that by 2050 entire planes could be built of 3-D printed parts. GE is already using printers to make fuel-nozzle tips for jet engines. And interest isn't limited just to corporate giants.

"WE ALL KNOW THAT 3-D printing is going to play a big role in the future," says Hedwig Heinsman, one of the partners in the Dutch architectural firm DUS, which is printing a house on the banks of Amsterdam's Buiksloter Canal.

Over three years a 20-foot-tall printer, the KamerMaker (Room Maker) will create walls, cornices, and rooms, trying out materials, designs, and concepts. "I can see a time coming where you will be able to choose and download house plans like you were buying something on iTunes, customize them with a few clicks on the keyboard to get just exactly what you want, then have a printer brought onto your site and fabricate the house," adds Heinsman.

Additive manufacturing—as 3-D printing is also called—has been around for about 30 years. It's the quick pace of advances that has created the recent buzz and inspired some grandiose

Architect Hans Vermeulen stands on the 3-D printed cornerstone (bottom) for a canal house in Amsterdam (artist rendition, top). The blocks needed to build the 13-room house will be printed with a specially developed bioplastic compound that's 80 percent vegetable oil. Other printable materials, including powdered marble for bathrooms, will be tested during the three-year project.
DUS ARCHITECTS (TOP)

Roff Smith writes regularly for the magazine. Robert Clark photographed a royal Peruvian tomb for the June 2014 issue.




3

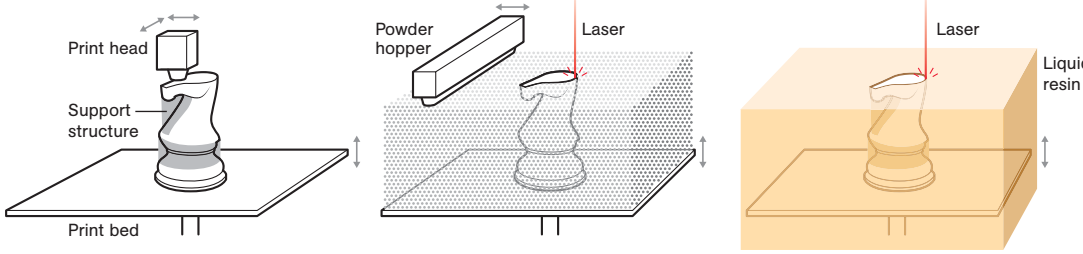




In a shot heard round the world, political activist Cody Wilson rattled law enforcement authorities in 2013 when he successfully test-fired his single-shot .38-caliber Liberator, but these 3-D printed guns sometimes fail (above). Others have since tested designs for plastic guns, and one company has even printed a working Browning Model 1911 .45-caliber pistol in metal.

3 WAYS TO PRINT IN 3-D

The term "3-D printing" includes a number of different technologies, but they all rely on the same basic principle: building up an object by adding material layer by layer. The methods, which vary in cost, speed, accuracy, and materials, each have their own advantages.



Fused Deposition Modeling
Plastic filament is fed into a printer, melted, and deposited in layers, which harden. The process is suitable for an office, making this an ideal technology for desktop consumer printers.

Selective Laser Sintering
Fine powder, such as metal or plastic, is laid down, and a laser passes over it, selectively fusing it to the layer beneath. This allows a broad range of materials to be printed.

Stereolithography
A photosensitive liquid resin is exposed to a laser or ultraviolet light, which hardens it. The process is fast and can create high-resolution shapes, but yields objects with limited material strength.

MATTHEW TWOMBLY AND ALEXANDER STEGMAIER, NGM STAFF. SOURCE: HOD LIPSON, CORNELL UNIVERSITY

predictions. But there is a huge and possibly unbridgeable gap between what can be made on highly sophisticated commercial 3-D printers and what you can make on a home printer. A 3-D printer works in much the same way as a desktop printer does. Instead of using ink, though, it "prints" in plastic, wax, resin, wood, concrete, gold, titanium, carbon fiber, chocolate—and even living tissue. The jets of a 3-D printer deposit materials layer by layer, as liquids, pastes, or powder. Some simply harden, while others are fused using heat or light.

THE HIGH COST OF TOOLING UP a factory has long been a barrier to developing niche products. But now anyone with an idea and money could go into small-scale manufacturing, using computer-aided design software to create a three-dimensional drawing of an object and letting a commercial 3-D printing firm do the rest.

Since a product's specifications can be "retooled" at a keyboard, the technology is perfect for limited production runs, prototypes, or one-time creations—like the one-third-scale model of a 1964 Aston Martin DB5 that producers of the James Bond film *Skyfall* had printed, then blew up in a climactic scene.

And because a 3-D printer builds an object a bit at a time, placing material only where it needs to be, it can make geometrically complex objects that can't be made by injecting material into molds—often at a considerable savings in weight with no loss in strength. It can also produce intricately shaped objects in a single piece, such as GE's titanium fuel-nozzle tips, which otherwise would be made of at least 20 pieces.

A one-piece chair designed to resemble spongy human bone tissue was printed in epoxy (top right). A model shows a titanium plate behind the face of a patient who lost his cheekbone, upper jaw, and right eye to cancer (bottom). Engineers created the implant using digital scans of the healthy side of his face and a 3-D printer.

SOURCES: MATHIAS BENGTSSON STUDIO (CHAIR DESIGN); MATERIALISE (PRINTING); JAN DE CUBBER









Fashion model Devon Windsor prepares to take to the runway at the Ready to Wear fashion show at Cité de la Mode et du Design in Paris. The dress that she's wearing, a collaboration between a fashion designer and an architect, was made on a 3-D printer.

IRIS VAN HERPEN (DESIGNER); JULIA KOERNER (ARCHITECT). MANUFACTURED IN COLLABORATION WITH MATERIALISE

Glowing in black light, this "scaffold" (top right) was made by a Harvard University lab that used a similar method to 3-D print living tissue with blood vessels using biological inks. The researchers hope this will lead to printable tissues for drug screening, regeneration, and ultimately, organ transplant. They also made the world's smallest lithium ion battery (bottom), just a millimeter wide, which could power medical implants.

SOURCE: LEWIS GROUP, HARVARD UNIVERSITY (BOTH)

This same precision is making it possible to fabricate things never before made. A team of Harvard University researchers has printed living tissue interlaced with blood vessels—a crucial step toward one day transplanting human organs printed from a patient's own cells. "That's the ultimate goal of 3-D bio-printing," says Jennifer Lewis, who led the research. "We are many years away from achieving this goal."

Additive manufacturing is much slower than traditional manufacturing, but that could change, says Hod Lipson, a professor at Cornell University long involved with 3-D printing.

"Printer speed, resolution, and the range of materials that can be printed are all being developed right now, along with printers that are capable of printing with multiple materials and creating objects with working parts and active circuitry," Lipson says.

He and his team printed a replica of Samuel Morse's telegraph. With a nod to history, they tested it by tapping out the message an awed Morse sent in 1844: "What hath God wrought?"

GOD MAY HAVE WROUGHT the principles, but people are pressing the buttons. In May 2013 a political activist named Cody Wilson grabbed headlines when he announced the test-firing of the world's first 3-D printed handgun, the Liberator, a single-shot .38-caliber pistol made with $60 worth of plastic.

The news initially unnerved law-enforcement officials, who foresaw disposable, untraceable guns printed like term papers. But making a reliable gun is not simple—or cheap. When a California firm, Solid Concepts, printed a limited edition of a hundred Browning Model 1911 .45-caliber pistols, it did so with a printer and facilities that cost the better part of a million dollars.

"It's simply a lot easier for crooks to get hold of a gun the old-fashioned way—buying them or stealing them—than to fuss over a 3-D printer for a couple of days, only to end up with a warped plastic blob or, even worse, something that blows up in their hands," says Jonathan Rowley, design director of Digits2Widgets, a London 3-D printing firm that made the parts of a nonworking version of Wilson's gun for the Victoria and Albert Museum.

Few people will be crushed by not being able to print a Saturday night special, but many may be disappointed with the misshapen trinkets that are the typical fare. "People read about the fabulous things that are being made with 3-D printing technology, and they are led to believe that they will be able to make these things themselves at home and that what they turn out will be of a really high standard of workmanship," Rowley says. "It won't be."

While consumer printers may one day allow us to make whatever we like, Rowley envisions a different grassroots revolution, one where people can test ideas that once would never have made it off the back of an envelope.

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VIDEO

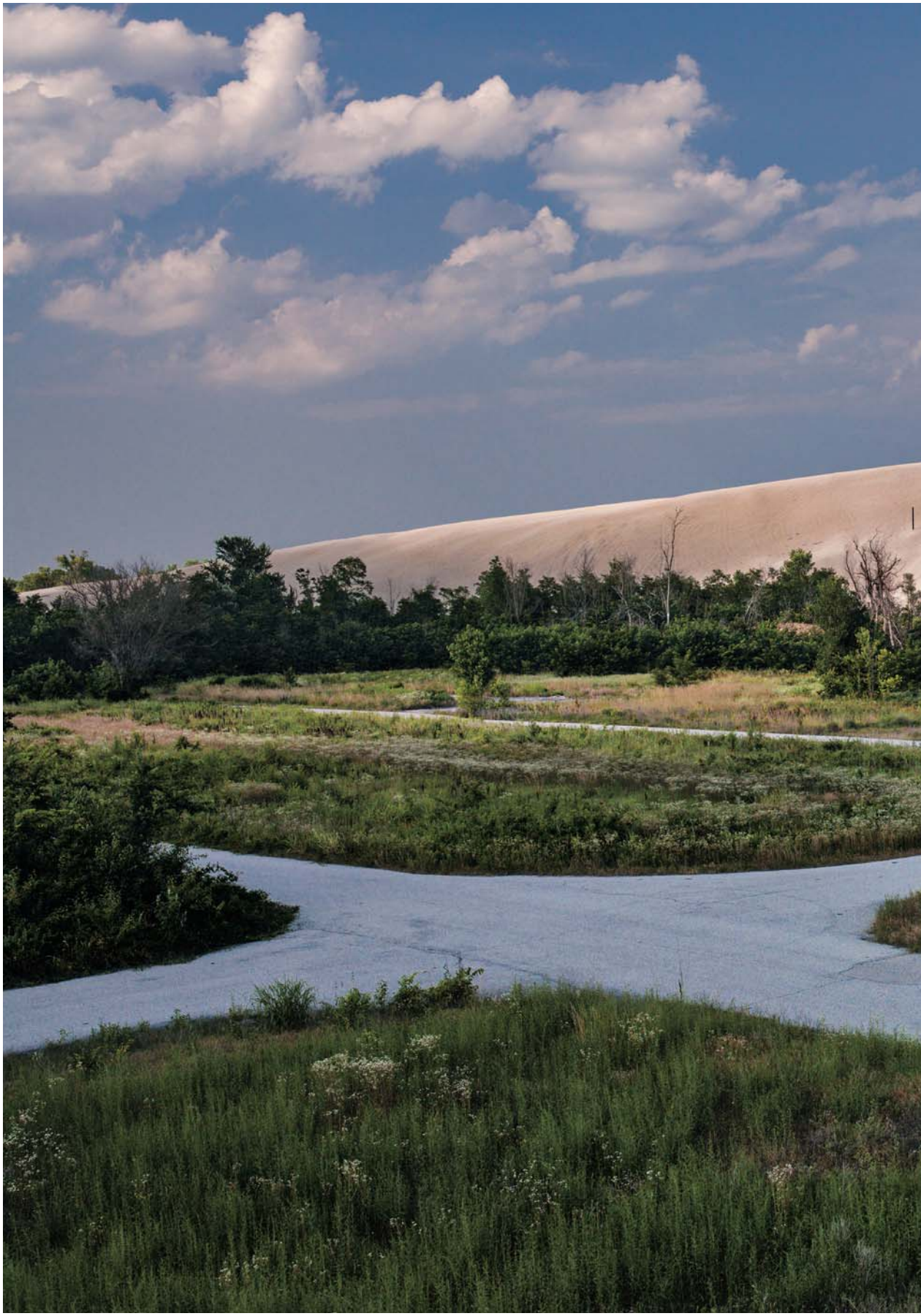
A Prehistoric Print Job

Watch as a *Homo habilis* skull emerges from a 3-D printer—an hours-long process reduced to minutes, thanks to time-lapse photography.









No one talks much about toxic Superfund sites anymore. But 49 million Americans live close to one.

Wasteland



TAR CREEK
Picher, Oklahoma

Dunes of waste rock from long-shuttered lead and zinc mines rise above Ethel and Fifth Streets in a town that no longer exists. Before this place became a Superfund site, children played on the dunes, and the wind blew toxic dust into homes. Water flowing through the mines still pollutes Tar Creek. But Picher's residents are now gone, thanks to federal buyouts. Some 800 houses were razed; the town was dissolved last year.

Pollutants: lead, zinc, cadmium
Year listed: 1983

By Paul Voosen
Photographs by Fritz Hoffmann

For most of his adult life Jun Apostol has lived, willingly, in the shadow of a mountain of waste.

An accountant who's now retired, he planted his family in 1978 in a modest new house in Montebello, an industrial cum bedroom community just east of Los Angeles. Behind the house, in neighboring Monterey Park, sat an active landfill—but don't worry, the developer said. Soon it would close and become a park or maybe even a golf course.

The greens never came. It turned out that the landfill, a former gravel pit that had welcomed so much ordinary trash it had filled to ground level and then kept on rising, had also accepted some 300 million gallons of liquid industrial waste—and it hadn't been selective. Was your waste laced with arsenic, 1,4-dioxane, or mercury? No problem. The nodding pump jacks nearby, left from the oil boom, wouldn't care. Some of the waste might have come from drilling those oil wells.

Los Angeles had buried the hazardous waste, but it was far from gone. A few years after Apostol's development was built, his neighbors began complaining of nausea. Gas had intruded into six homes. Property values plummeted. In 1986 the U.S. Environmental Protection Agency marched in and listed the landfill as a Superfund site, part of its new program to contain the nation's hazardous waste crisis.

Back then many hoped the national cleanup might end after a decade or two. That didn't happen at the Operating Industries, Inc., landfill in Monterey Park. The EPA capped the landfill with a processed-clay membrane and two feet of soil. Gases from the waste are now collected and burned; a treatment plant processes 26,000 gallons of contaminated water a day. The EPA has so far recuperated $600 million for the cleanup from various parties responsible for the waste at the site—and it does not foresee an end to its work.

No one talks about the dump anymore. "People have forgotten about it," Apostol said one afternoon in his indoor patio, with music jingling on his speakers and his small dog, in a faded "Romney 2012" sweater, yapping for attention. House prices are up again, he said, and most residents have stayed put. His wife got breast cancer, but he doesn't blame the landfill. He's come to respect it since the EPA intervened: It's so heavily managed that, unlike people in neighboring towns, he doesn't worry about mudslides.

"We don't have any regrets," Apostol said. "Where else can you go?" He could have moved, he admitted, but the commute from Montebello was too good. Living next to a waste site may not be ideal. But neither is bad traffic.

TODAY NEARLY ONE IN SIX Americans lives within three miles of a major hazardous waste site, though few people could tell you where it is. These sites fall under the Superfund program, created by Congress in 1980 after a high-profile controversy at the Love Canal development in Niagara Falls, New York. Love Canal's residents crusaded against the Hooker Chemical Company after they found barrels of its chemical waste

Paul Voosen is a reporter for the Chronicle of Higher Education. *Fritz Hoffmann's latest article for the magazine was on longevity, in May 2013.*



LOVE CANAL
Niagara Falls, New York

"Not in my backyard." The phrase, like the Superfund law, may have its roots here, where homes were built on a chemical waste dump.

in their backyards, which had been built on a former dump. Love Canal left many Americans wondering, Could this be happening near me?

There are more than 1,700 Superfund sites, and each has a story. Some are sacrifices to national security, like the 586 square miles at Hanford, in Washington State, where reactors have made plutonium for atomic bombs since the Manhattan Project. Others are the shells of mines, like the Berkeley Pit in Butte, Montana, excavated in pursuit of copper and now filling with water. There are chemical manufacturers, smelters, and grain elevators that were once drenched in fumigant. Water, which can spread poison, is a common theme: New York City's Gowanus Canal is listed, as are parts of the Hudson River and the harbor of New Bedford, Massachusetts. And then there are the many, many landfills.

That these contaminated places are no longer the focus of national attention is in part due to a rarely cited phenomenon: governmental competence. Despite chronic underfunding, the EPA has finished the cleanup at more than 380 sites and considers the construction of treatment facilities complete at more than 1,160 others, including Monterey Park. Not everything is rosy. Even where the waste is under control it's still there—and the agency estimates it has 95 uncontrolled sites, where people might one day be exposed to toxics. But the urgency of the 1970s has, for the most part, passed.

Money remains a constant problem. The Superfund program once had two pillars: rules that held past polluters liable for cleanup and a "Superfund"—financed by taxes on crude oil and chemicals—that gave the EPA the resources to clean up sites when it could not extract payment from the responsible parties. Congress let those taxes expire in 1995; the program is now funded by taxes collected from all Americans. It's low on staff. The Superfund itself is nearly empty.

Superfund sites have entered a mostly benign but lingering state, dwarfed in the public's eye by issues like climate change, says William Suk, who has directed the National Institutes of Health's Superfund Research Program since its inception in the 1980s. "It's not happening in my backyard, therefore it must be OK," is how Suk sees the prevailing attitude. "Everything must be just fine—there's no more Love Canals."

Back when leaking drums were cropping up in people's backyards, the fear was that hazardous waste would drive a cancer epidemic. That prediction hasn't come true. Identifying a statistically significant cancer cluster is notoriously difficult, but so far at most three have been tied to hazardous waste in the U.S. (Love Canal is not one of them.) Forty percent of Americans will be diagnosed with cancer during their lifetime, mainly the result of random errors in their DNA that arise as cells divide. As a risk factor, pollution in general ranks below smoking, obesity, diet, alcohol, and several viruses.

That's not to say that hazardous waste sites are safe. Cancer is only one danger associated with them; birth defects are another. A ghost of uncertainty attends these polluted places. Suk offers the Cuyahoga River in Ohio as an example. When it caught fire in 1969, it helped

BETTMANN/CORBIS



OPERATING INDUSTRIES LANDFILL
Monterey Park, California

When Jun Apostol moved in next to this suburban landfill 36 years ago, he hoped it might become a golf course someday. Gases percolating up from L.A.'s industrial past ended that dream. A system for containing the waste was completed in 2012. Today Apostol limits his putting to the backyard.

Pollutants: 1,4-dioxane, vinyl chloride, methane, metals, volatile organic compounds
Year listed: 1986







GOWANUS CANAL
New York, New York

Carved from a tidal estuary 160 years ago, the Gowanus Canal is Brooklyn's industrial artery—and a deeply polluted waterway. Even so, it's frequented by herons, seagulls, crabs, and canoeists. Defying local fears of economic stigma, the EPA listed the canal as a Superfund site in 2010. It hopes to start dredging contaminated mud in 2016.

Pollutants: polycyclic aromatic hydrocarbons, polychlorinated biphenyls (PCBs), mercury, lead, copper
Year listed: 2010



SILVER BOW CREEK/ BERKELEY PIT
Butte, Montana

In 1982 copper miners abandoned this 1,246-foot-deep hole. Now groundwater seeping through thousands of miles of mine galleries is filling the pit with metal-rich water. Before the water rises high enough to threaten Silver Bow Creek—which has already been cleaned of mine tailings—the EPA will require the responsible companies to pump water out of the pit and treat it.

Pollutants: copper, arsenic, cadmium, lead, sulfate, zinc, aluminum, iron
Year listed: 1987

PANORAMA COMPOSED OF TWO IMAGES

lead to passage of the Clean Water Act and to cleaner rivers all over the U.S.—but it and other rivers are far from clean enough. "It's not on fire anymore," Suk says. "But I wouldn't swim in it."

HOW DO WE LIVE WITH contaminated land? We need to find more ways to use these brownfields instead of green ones, says ecologist Erle Ellis of the University of Maryland, Baltimore County. "Brownfields are important to cities," he says. "In a sense they're waste, but so is manure. It's just something that needs to get recycled."

The EPA agrees. It's seeking uses for polluted land that could remain under its oversight indefinitely. "Basically we'll be here forever," says Julie Santiago-Ocasio, the EPA's site manager at Monterey Park. It costs $5.5 million a year to treat leachate and landfill gas and make sure that contaminated groundwater doesn't spread off the site—but a small pilot plot of solar panels atop the landfill offers hope that one day it might collect a lot of solar energy as well.

A more dramatic kind of reuse is happening at the former Rocky Mountain Arsenal, near



Denver. During World War II the U.S. Army made mustard gas at the site, which is about the size of Manhattan, and later the nerve gas sarin; the Shell Chemical Company produced the pesticide dieldrin there. Waste was shunted into a basin that became a black hole of contamination.

When Sherry Skipper first arrived at the site as a young biologist in the early 1990s, she would often don booties, respirators, and goggles to check on starlings she was using, like canaries in a coal mine, to monitor pollution. The birds fed on worms and burrowing insects that accumulated dieldrin. Skipper remembers one damp spring in particular when the earthworms emerged—and birds that ate them fell out of trees, convulsing. "That's never going to happen again," she said one day last winter.

The place is now a wildlife refuge, and Skipper was riding around it with its manager, David Lucas of the U.S. Fish and Wildlife Service. It's a wholly altered landscape. The chemical facilities were razed between 1999 and 2003 and covered with a "biota barrier"—ground-up tarmac from the old Denver airport topped by four feet of soil—to keep animals from burrowing into the contamination. Native prairie grasses now whisk water away from it. On the refuge's fringes, wells block the spread of polluted groundwater. New town houses have sprouted on the border.

With the Denver skyline as a backdrop, we watched for bald eagles—up to 80 of them roost here during winter. There are bison, prairie dogs, and mule deer. People should never live on the site itself, Skipper said. But there's an upside to that. "What are the chances," Lucas said, "that there'd be 16,000 acres right here in the middle of Denver—undeveloped, for wildlife—if it wasn't a Superfund site?" ▯

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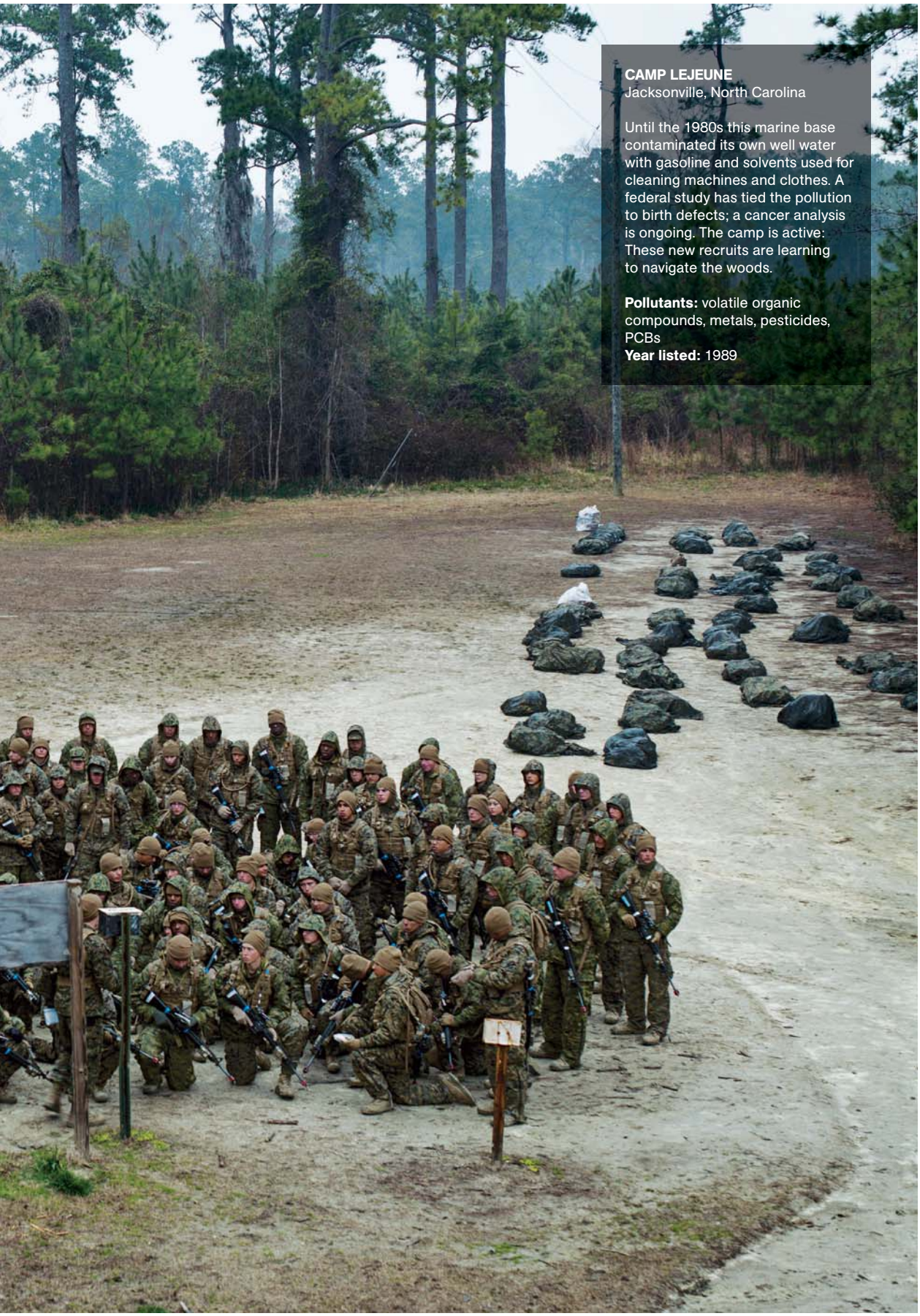


HANFORD SITE
Richland, Washington

A small part of the nuclear weapons program that began in 1943, the K-East nuclear reactor, one of nine on the Columbia River, is now part of a 586-square-mile cleanup that began in 1989. The current government plan is to shroud K-East in steel and let the radioactivity in it wane for 75 years—then find a place to store it.

Pollutants: hexavalent chromium, carbon tetrachloride, uranium, plutonium, strontium, cesium
Year listed: 1989


VL88

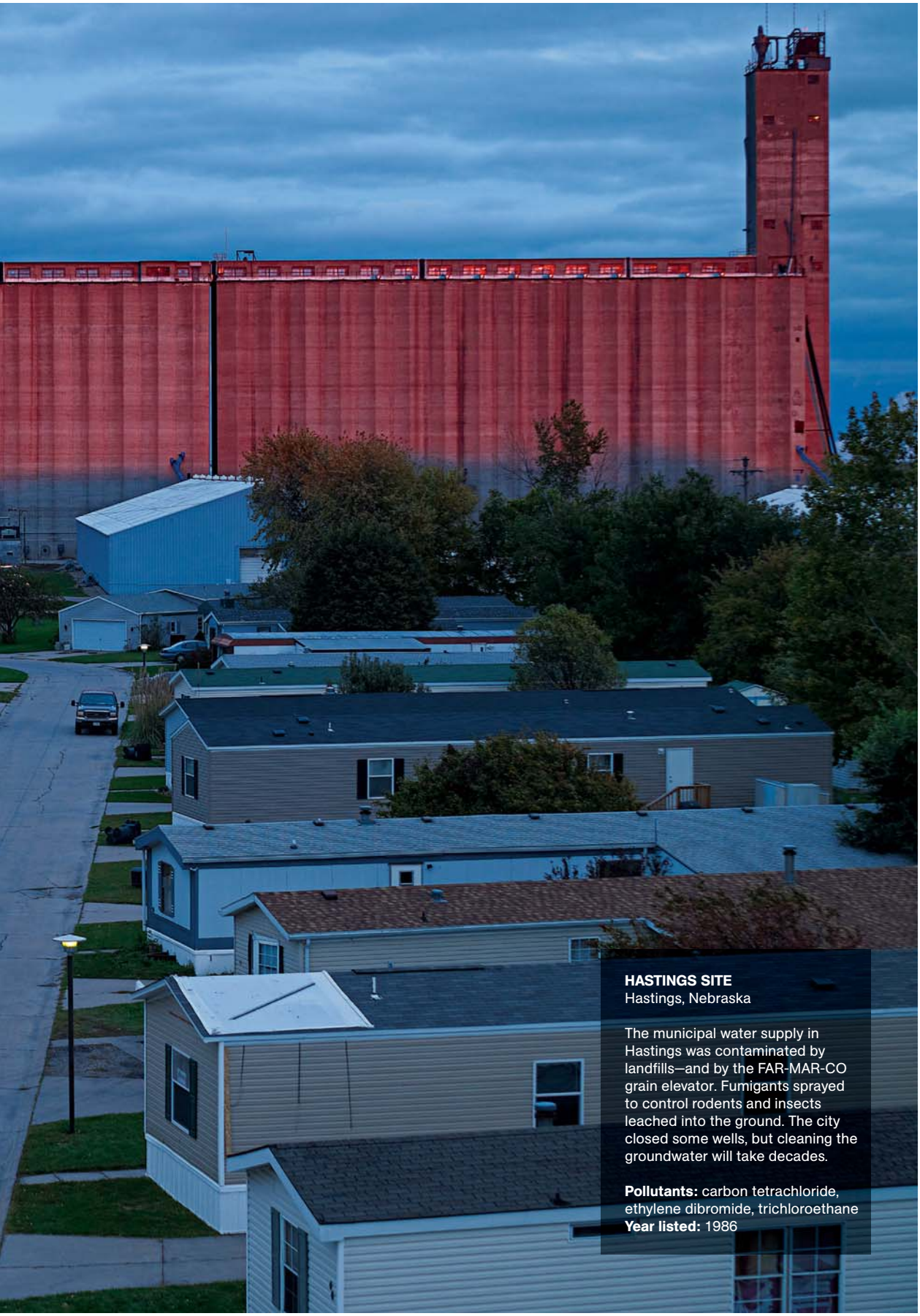


CAMP LEJEUNE
Jacksonville, North Carolina

Until the 1980s this marine base contaminated its own well water with gasoline and solvents used for cleaning machines and clothes. A federal study has tied the pollution to birth defects; a cancer analysis is ongoing. The camp is active: These new recruits are learning to navigate the woods.

Pollutants: volatile organic compounds, metals, pesticides, PCBs
Year listed: 1989

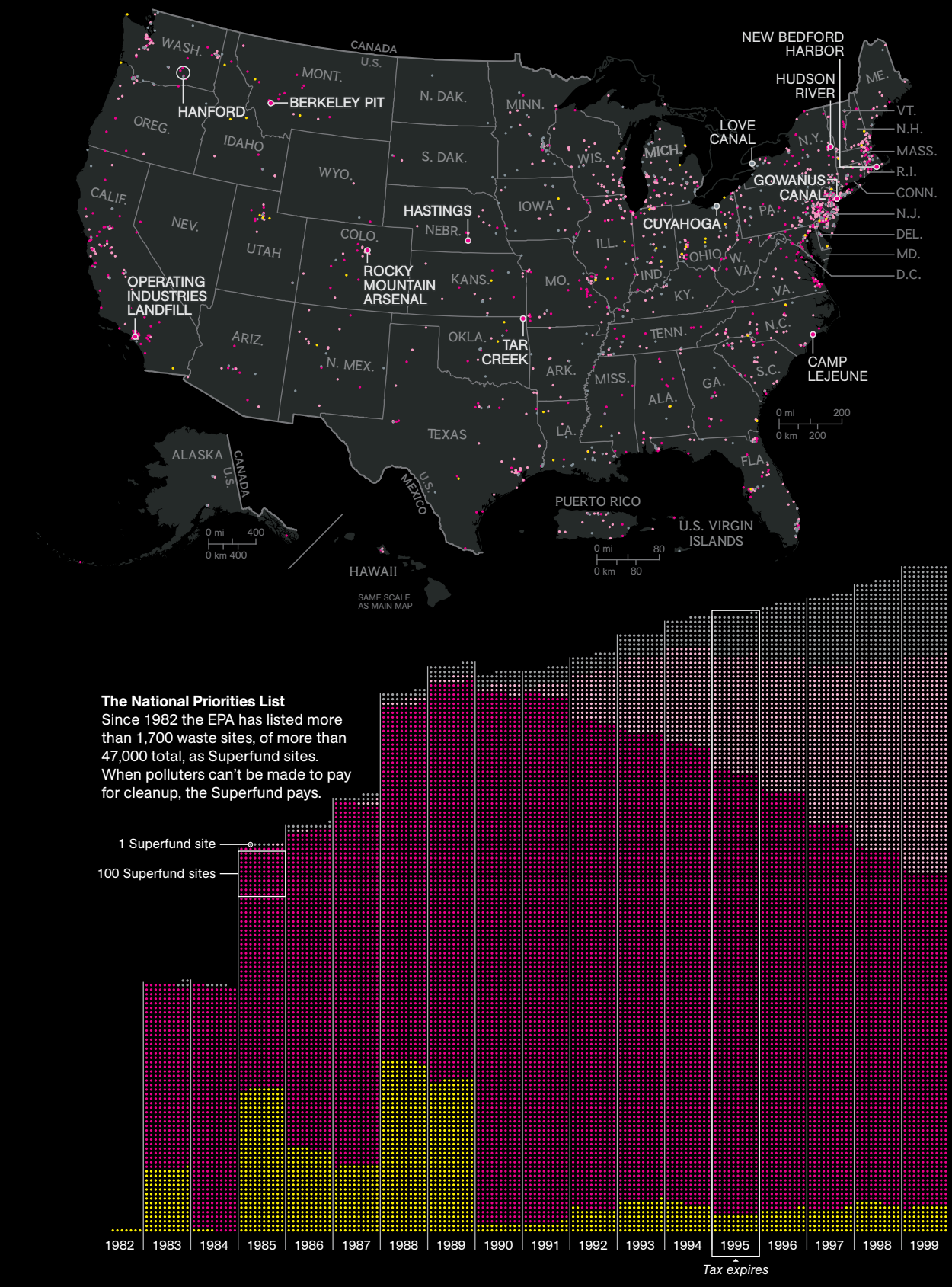




HASTINGS SITE
Hastings, Nebraska

The municipal water supply in Hastings was contaminated by landfills—and by the FAR-MAR-CO grain elevator. Fumigants sprayed to control rodents and insects leached into the ground. The city closed some wells, but cleaning the groundwater will take decades.

Pollutants: carbon tetrachloride, ethylene dibromide, trichloroethane
Year listed: 1986

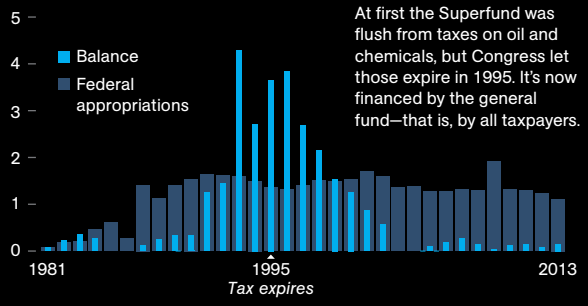


The National Priorities List
Since 1982 the EPA has listed more than 1,700 waste sites, of more than 47,000 total, as Superfund sites. When polluters can't be made to pay for cleanup, the Superfund pays.

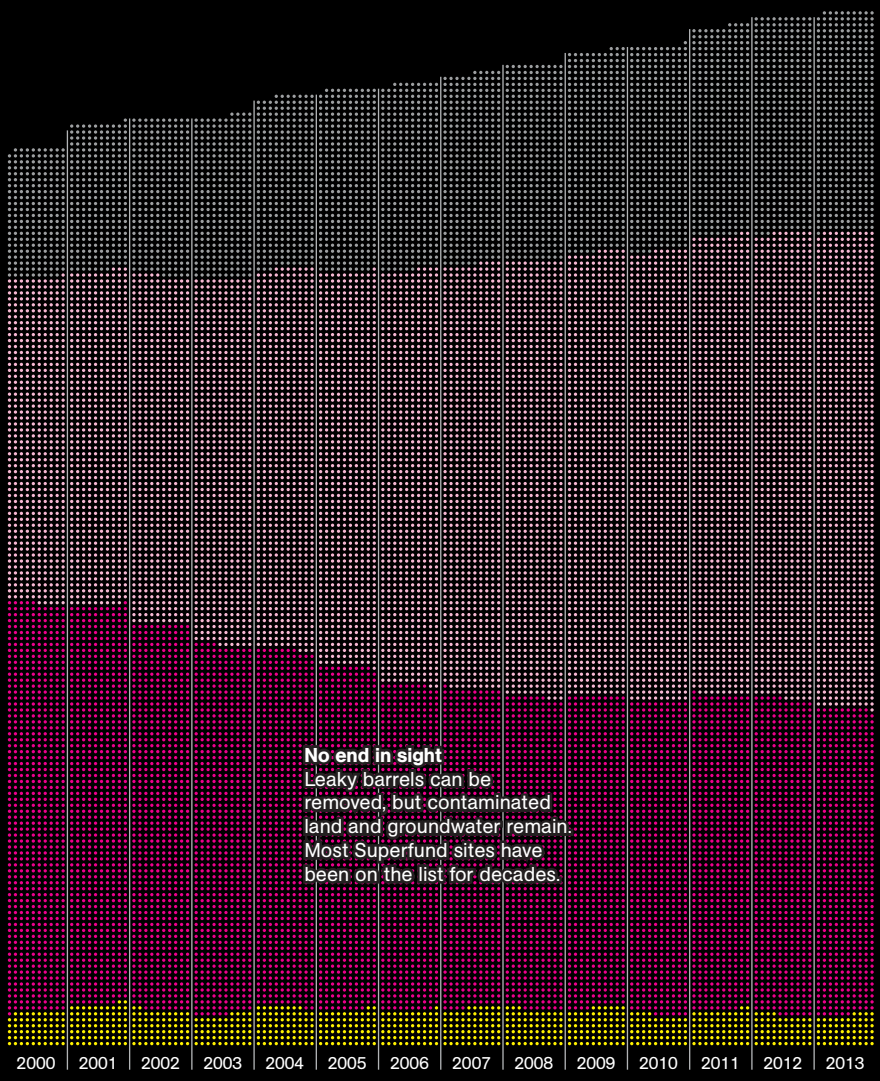
A Nationwide Cleanup

Since Congress passed the Superfund law in 1980, many of the worst hazardous waste sites in the U.S. have either been cleaned up or brought under control. But hundreds more are works in progress—and 95 of them, says the EPA, may be exposing humans to dangerous levels of toxic chemicals. A depleted Superfund and shrinking appropriations from Congress have delayed cleanup at some sites.

Status of the fund
in 2013 dollars, billions



At first the Superfund was flush from taxes on oil and chemicals, but Congress let those expire in 1995. It's now financed by the general fund—that is, by all taxpayers.



NATIONAL PRIORITIES LIST STATUS, 2013

Deleted: 370
All cleanup efforts have been completed, and the site has been removed from the National Priorities List.

Construction completed: 790
All the physical facilities necessary for cleanup—a landfill cap, say, or a water treatment plant—have been built. These facilities may need to be operated and maintained indefinitely.

Active: 525
Cleanup facilities have not yet been completed.

Proposed: 54
Sites have been studied, and cleanup plans proposed.

Numbers shown are statuses as of the end of each fiscal year (September 30).

JASON TREAT, NGM STAFF; MEG ROOSEVELT AND JAMIE HAWK. SOURCES: EPA; GAO

COWBOYS ON

In the wilds of Patagonia, cowboys called bagualeros pit themselves against the meanest livestock on the planet.



THE EDGE



Bagualeros—cowboys who capture feral livestock—pause in their search for cattle on Antonio Varas Peninsula, in Chilean Patagonia. Few choose the bagualero way. "It's a beautiful life but a tough one," says Sebastián García Iglesias (at far left).



After their dogs cornered a feral bull, bagualeros, following on horses, roped it. Subduing these animals



can take hours, and this bull couldn't be controlled. It was killed to feed the men and their dogs.



Sebastián García relaxes with his dog after roping a bull. The unequivocal brutality of rounding up feral



livestock is offset by a deep tenderness between men and dogs. “Without them we are nothing,” he says.

By Alexandra Fuller
Photographs by Tomás Munita



Working in treacherous terrain engenders camaraderie among bagualeros. "It's easy to trust someone who has absolute trust in himself," says Abelino Torres de Azócar (at near right).

This is a story about blood, courage, and tradition, and like most stories of this nature, there are horses involved, and men of unlikely skill and reticence, and yes, of course, lives and limbs are at risk. Also, like most stories of this nature, the landscape is mythically wild, partly because it is so remote and therefore almost impossible to reach by ordinary, convenient means. If you know where to look, you can see Sutherland on a topographical map, a finger of land pointing into Chile's Última Esperanza Sound, in southern Patagonia. But there are no roads near the place, and no settlements. To the north—but again, not accessible by ordinary means—there is Torres del Paine National Park, and beyond that the wild and impassable northern ice fields that cut off Chile's Patagonia from the rest of the country. To the west, scores of little islands make a puzzle of the southern Pacific. To the east, there is the sound—often thrown into a fury by the infamous wind here, and therefore not always safely navigable—and at last Puerto Natales, with its pleasant, touristic shops and restaurants.

Sebastián García Iglesias, a 26-year-old agricultural engineer by trade but cowboy at heart, is worn wise in the manner of one who has been raised around large animals. His legendary great-uncle, Arturo Iglesias—whom Sebastián is said to resemble to a haunting degree—was born in the town of Puerto Natales in 1919. The Iglesias family was one of the first to settle this area in 1908, setting up a general store for pioneers. Shortly after that the family established Estancia Mercedes on a piece of land nestled picturesquely against the sea, with its back to the mountains. Then, in 1960, Arturo acquired Estancia Ana María, a ranch that can be reached only by boat, or by a ten-hour horse ride if you are willing to cross a bog in which your mount will repeatedly sink up to its belly. And as if Ana María were not remote enough, Arturo created a settlement in Sutherland, a nearly unreachable area within Estancia Ana María. Once in its history, a ranch hand, his wife, and their two children lived in a little house in Sutherland, but the wife—perhaps driven mad by the isolation—ran off with a fisherman, and eventually the ranch hand and his two motherless children left and drove the cattle back to civilization.

Stragglers from Arturo's herd turned feral and bred, natural selection making them bigger and fiercer, and every summer Arturo rounded them up, riding from Estancia Ana María with his cattle dogs and his most trusted horses. Sometimes he sent the wild cattle—*baguales,* they're called, which translates as "savage livestock" rather than



merely "wild"—to market in Puerto Natales by boat, and sometimes he herded them by land along knife-edge cliffs, through bogs, and over slick rocks, riding with a packhorse and a wild bull in tow, a hand-rolled cigarette perpetually pasted to his lower lip.

But now the Iglesias family—which is to say all the extended family of aunts and uncles and cousins who had little or no emotional connection to the place—had decided to sell Ana María, including Sutherland, to a wealthy cattle rancher. The rancher had given Sebastián permission to retrieve baguales on the land one final time. Accordingly, Sebastián set about finding the finest *bagualeros* in Puerto Natales to assist him, and perhaps in part because he hopes one day to take tourists *bagualeando,* and so keep the tradition alive, he allowed us to tag along.

So it was clear from the outset: This expedition to Sutherland would be no ordinary cattle drive to market. For a start, the baguales of Sutherland were baguales that hadn't seen a rope in generations. And just to get to Sutherland, we would be riding with Sebastián and three other bagualeros, 20 horses, and 30 dogs for at least a couple of days through the kind of terrain that rewards a false step with whatever comes after life.

I phoned home for moral support. "I've been told to pack goggles," I told my father. There was a brief silence. "Goggles are for invading bloody Poland, not rounding up a couple of cows," Dad said. He's a British-born Zambian farmer in his 70s, and he thinks nothing of plunging into the Zambezi Valley darkness to chase elephants off his bananas or scare crocodiles out of Mum's fishponds. "What's the object of the exercise?"

"Find a tree," I'd been advised. But before I could move my horse, the bull pitched into view, flanks heaving. It appeared to be taking stock.

"Fifty baguales, if they can get them," I said—so money, of course, but also something harder to define.

Mum got on the phone. She reminded me that she'd dragged me along on her cattle raids when I was a child, rustling cows on the Mozambique border during the Rhodesian bush war. "I remember," I said. "I was very brave."

"Rubbish," Mum said. "You were a wimp." I could hear Dad in the background interjecting that if I survived the bulls, there were a couple of crocodiles in the fishponds I could wrestle if I liked. The goggles might come in handy for that, he said. My parents dissolved in shrieks of laughter.

I DIDN'T PACK THE GOGGLES, but by the time I encountered a bagual in Sutherland, that turned out to be the least of my worries. The foliage in front of us crashed as if being felled by a bulldozer. "Find a tree," I'd been advised. But before I could move my horse, the bull pitched into view. Even with 30 dogs at its ears and heels, ripping at the soft flesh below its tail, the animal still seemed indestructible and bent on wreaking havoc. The bagualeros were nowhere in sight. The bull stood its ground, flanks heaving. It appeared to be taking stock. Anyone who thinks it's foolish to ascribe emotions to animals hasn't looked into the eyes of a baleful feral bull.

I turned my horse up a bank toward a stand of trees. As a child I'd spent hours in the branches of a muscular flamboyant, where I had felt both invisible and more powerful. But I had long ago lost that magical thinking, and this bull looked more than equal to any tree I could get into, even if I scrambled up from the advantage of my saddle. "The bulls will charge you," I had been warned. "So climb high."

The night before, Abelino Torres de Azócar, a 42-year-old bagualero of inhuman ability and unflappable dignity, had told us a story from a long-ago expedition. "I don't know if this bull was the devil, or what," Abelino had said. "We placed traps, we shot him, we stabbed him, but he would never die." One night the bull came into camp and attacked the bagualeros where they slept. "We heard branches breaking, but we didn't have time to escape. The bull destroyed the whole tent with us inside it. We were covered in cuts and bruises."

At the time I had recognized the story as the sort commonly told around southern African campfires to pass the hours between supper and sleeping bag. The appeal of these stories—a missionary's brother trampled by an elephant, a professional hunter shot by his own client—lies partially in the assurance that the misadventure won't happen to you.

But now this story did seem to be about to happen to me. Tough people had raised me to be uncomplaining and stoic, but unless tested, it's hard to know the limits of your courage and endurance.

SEBASTIÁN HAD ASSURED US a ferry would come to Sutherland to collect the baguales, the dogs, the horses, and us, but it had been a difficult ride in. Instead of a day or two, it had taken a week, the vegetation having grown back with seeming vengeance since Arturo's day. "We'll get to Sutherland tomorrow," Sebastián said more than once. But the horses kept trying to turn around, slithering on the rain-slicked ground. Twice a

Alexandra Fuller's latest book, Cocktail Hour Under the Tree of Forgetfulness, *was a* New York Times *best seller. Photographer Tomás Munita lives in Santiago, Chile. This is his first* Geographic *story.*

packhorse fell off the trail, rolling helplessly until lodged by a tree or rock. It took hours to right it each time, the dogs nipping at its legs, the men pulling on ropes. "Everything's going perfectly," Sebastián told his girlfriend on the last thread of cell phone reception we'd have for some time. She begged him to consider turning back before it was too late. "No, no. It's all great," he said.

On the third night, with Sutherland still an uncertain number of days away, we ran out of food. Hunger on the trail wasn't anything the bagualeros hadn't encountered before. They habitually traveled light rather than overburden the already struggling horses. "Watch the dogs, though," they warned from experience. "They'll start eating our leather." But the dogs, apparently equally experienced, were stealthy. As we dried sodden clothes and tried to warm ourselves around a fire, the dogs ate the straps off Sebastián's spurs, the leather cover off a bottle, the girth off a saddle. "We'll find a bagual tomorrow, and then we'll eat," Sebastián said.

On the fourth morning the bagualeros breakfasted on cigarettes and yerba maté—an appetite-suppressing herbal tea that delivers the jolt of a strong cup of coffee—and left camp early to forge a trail forward. I stayed in camp, charged with keeping the fires going, the dogs from the leather, and the horses from returning home. In three days I'd already lost weight—a couple of imperceptible pounds at first, then an unwelcome few more, and now the incessant cold had taken permanent hold, first of extremities, and then of bones. There was no way to get warm. Even close to the fire, the wind drove freezing rain into the makeshift shelter.

When the bagualeros returned to camp several hours later, they too were frozen and drenched to the skin, their hands torn from thorns and from their machete handles. They took turns steaming their clothes over the fire. Abelino wordlessly covered my shoulders with his dry jacket. "An abiding, instinctive kindness," I said afterward when someone asked what had most impressed me about the bagualeros—which is surprising only when you consider the direct brutality of their work.



NGM STAFF; INTERNATIONAL MAPPING

IF THERE WAS AN EASY, gentle way to get feral cattle out of Sutherland and to market, all alternatives fled my mind when that bull emerged from the forest. In most of the rest of the world, feedlots, cattle trucks, and abattoirs muffle the violence between the consumer and the consumed. Here the field was tilted more fairly in favor of the animal.

"A bagualero is someone who goes hand to hand with wild cattle, using human skills," Sebastián had explained. "With a gun you have too much advantage. But body to body you can lose; you're risking your life." In the mid-1960s Arturo was in his 40s when a bagual bull finally caught up with him in a peat bog we had crossed on the first day of our journey to Sutherland.

Arturo had dismounted from his horse, so he was forced to face the bull alone and unarmed—body to body, as Sebastián would have it. "Things didn't go so well for my great-uncle," Sebastián said. The bull smashed Arturo's teeth to splinters and with sweeping horns tore through his testicles. After that some shots were fired in the air by Arturo's compadres, and the bull retreated, leaving Arturo soaked in his own blood. Arturo asked to be helped back on his horse and rode to the Iglesias family's estancia, there to await a

boat that would ferry him to the nearest hospital.

When the professionals at the hospital in Punta Arenas saw Arturo, they offered to castrate him on the spot and thereby save the man from almost certain death by infection. Instead, Arturo begged the nurse to pack his wounded parts in salt. After that he insisted on having his smashed teeth replaced with dentures. He left the hospital fully intact as a man, with an unnaturally bright and even smile.

The question arose, "Is it worth it?" Of course, the answer to that question depended on what "it" was and by which set of values you balanced a life. In other words it depended on whether you valued the grandeur of suffering or the banality of comfort. And it depended on whether you do your life for a living. "A person who has no connection to their ancestors and to their land is condemned to tumble," Sebastián had said. "This is a way of life for us, not just a way to make money."

Which was just as well because it was obvious there wouldn't be 50 baguales to load onto the ferry back to market in Puerto Natales. Bad weather had driven most of the baguales far west of Sutherland, beyond the endurance of the horses and dogs. Instead of five baguales a day, they'd be lucky to get one every two or three days.

And even that modest number seemed an imposingly difficult achievement. Once the bagualeros managed to catch up with a bull and lasso it in the dense brush, they still had to dehorn it and tie it to a tree for a few days until exhaustion wore the bull pliable enough to be roped to a horse and persuaded onto the ferry.



In Tierra del Fuego a bagualero cautiously approaches a trapped feral horse. Alert and skittish, wild horses are typically harder to gather than cattle, and their meat, used mostly for jerky, isn't as valuable.

I WAS BEGINNING TO WONDER—out of line with Sebastián's belief in the power of positive thinking—if I'd be in one piece to see the end of this trip. After all, the very first bull I encountered seemed to have fixed its attention on me, and I still hadn't found a suitable tree to climb.

But then the four bagualeros suddenly appeared, riding with unimaginable speed through the forest, one hand on the reins, the other ready on a coil of rope. Seeing them, the bull fled into the trees, toward the lake. I followed at an immoderately safe distance. By the time I got to the lake, the bull had accidentally strangled to death on one of the ropes. In an effort to revive it, someone had pulled the creature's tongue from its mouth. Someone else was bouncing on its belly, CPR on a grand scale and to no avail. Life seeped from its eyes, which turned from black to glacial green. Abelino took off his hat and wiped his brow. Alive, that bull represented a month's salary. Dead, it was just meat for us and the dogs.

Over the next two weeks the men caught about a half dozen cows, several bulls, and a calf. One bull drowned itself in the lake; a cow jumped from a cliff and hanged itself. Our campsite churned redolent with animals and meat. The men grew lonely for women, and jokes were traded that no one would translate for my benefit. I did learn, however, that the brothel in Puerto Natales, a favorite haunt of Arturo's, had burned



to the ground some time ago. "Maybe someone set fire to it just to see the women running out," someone suggested wistfully.

The ferry could come to Sutherland only if the weather held. "It'll be fine," Sebastián said, against all evidence. But the ferry did come, and the bagualeros managed to load all the animals. Most of us made it out with scratches and bruises, a few with sore backs. The elderly packhorse was lame from its falls on the trail, but it limped willingly on board. One dog had been crushed against a tree by a bull and, disoriented by the trauma, had run home; another survived being swept away by a waterfall.

As the ferry turned toward Puerto Natales, I thought of what comes next for Estancia Ana María—the burgeoning tourism industry seems most likely to dominate the area's future. The baguales would no doubt be exterminated. The uncommon courage and swift brutality of the bagualeros would be a thing of campfire stories. The mystery and wildness of the place would be solved and tamed. Sebastián raised a beer and gave a toast to the land, to his ancestors, to us. "For this life!" he said. We all drank, then Sutherland was gone from view. □

MORE ONLINE

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VIDEO

What It Means To Be a Gaucho



Whether roping wild animals or riding them at a local rodeo, the bagualeros keep Patagonian tradition alive.



Darío Muñoz hurries to prevent his dogs from killing a cornered bull. Easier said than done.



Feral animals must be taken out of nearly inaccessible places alive if they’re to be sold for profit.



Financial pressures are forcing the Iglesias family to sell one of their two estancias. “Tourism is our future,”



says relative Hernán García (center), narrowing his eyes against smoke from the campfire in Sutherland.



On the way to Sutherland, Jorge Vidal coaxes horses along steep cliffs. A fall would mean certain death.



“If I could stay home with my family and still make a living, of course I would choose that,” he says.

A Prince of a Paramour

He builds her a cozy love nest. He woos her with long serenades. Once they start a family, he babysits. The guy is such a catch that one lady after another shows up to play house with him.

That's good news—because the more the southern corroboree frog *(Pseudophryne corroboree)* procreates, the better the chance of saving one of Australia's most famous and endangered amphibians.

At the start of breeding season the quarter-size male uses his hind limbs to sculpt moss into a chamber near a water source. He keeps up a courtship call until a female enters the nest. She lays 15 to 38 eggs, onto which he directly deposits sperm. She departs; he stays. All season he keeps calling, welcoming up to ten females, fertilizing clutches of eggs—even building a second chamber, if needed, for egg overflow. The male then stays in the nest for six to eight weeks, until the nest floods with fall and winter rains, in which his tadpoles hatch.

Drought can dry up breeding pools before tadpoles metamorphose. Bushfires claim habitat, and the chytrid fungus striking many frog species can kill corroborees before they reach breeding age. Today perhaps 50 exist in the wild. But breeding programs at the Melbourne Zoo and Sydney's Taronga Zoo placed hundreds of eggs in nest areas in 2014, in hopes of keeping suitors singing in the future. *—Patricia Edmonds*

HABITAT
Subalpine regions of Australia's Kosciuszko National Park

STATUS
Critically endangered

OTHER FACTS
The frog's skin secretes alkaloids that are poisonous to predators.

Drawn by the male's serenades, one lady frog after another comes to play house.



This frog was photographed at Zoos Victoria's Healesville Sanctuary, Australia.

PHOTO: JOEL SARTORE







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Tatra Chamois *(Rupicapra rupicapra tatrica)*
Size: Body length, 107 - 137 cm (42.1 - 53.9 inches); shoulder height, 70 - 80 cm (27.6 - 31.5 inches) **Weight:** 25 - 60 kg (55 - 132 lbs) **Habitat:** Steep, rocky mountainous areas, including alpine meadows and woodlands **Surviving number:** Estimated at 850

Photographed by Bruno D'Amicis

WILDLIFE AS CANON SEES IT

High life. The Tatra chamois makes its home in the rugged Tatra Mountains, where it nimbly forages for grasses, herbs, leaves, buds, shoots, bark and fungi. For most of the year, adult males are solitary, leaving flocks of females and young to their own devices. Every autumn, however, there is an epic clash as males battle for mates and drive young males from the flocks. This cycle of life is being seriously threatened by poaching, habitat disturbance and loss of genetic integrity due to interbreeding with the introduced Alpine chamois.

As Canon sees it, images have the power to raise awareness of the threats facing endangered species and the natural environment, helping us make the world a better place.



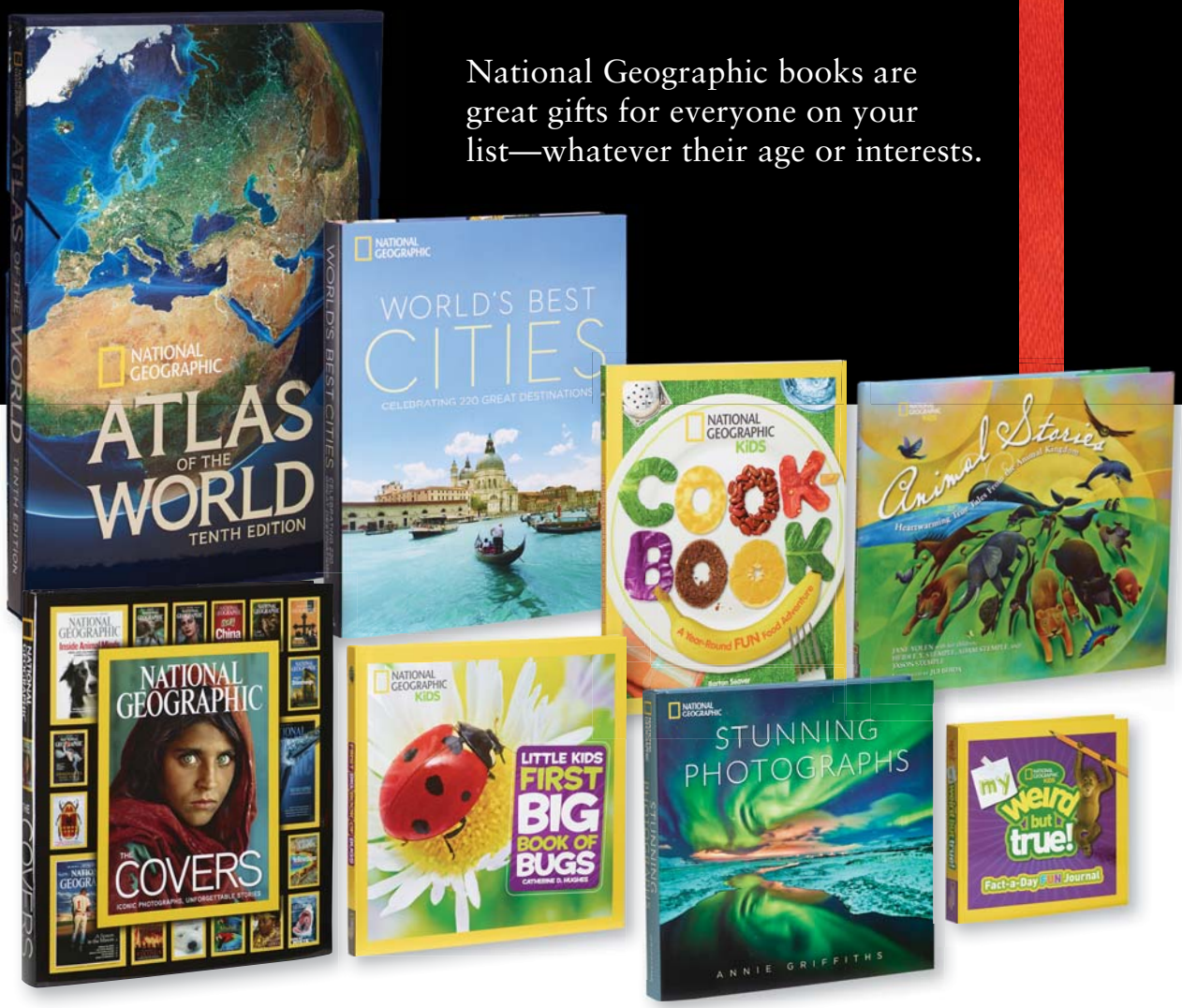
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